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JANUARY 3, 1958

electronics

engineering edition

ENGIN. LIB.

Reflex Circuit Trims Radio Cost ...p 66

Characters for CRT Readout ...p 72

Modern Sonar Systems ...p 56

Miniaturized Components...FROM STOCK

As leaders in miniaturization for over twenty years, UTC stock item units have provided smallest size with a maximum of reliability. Hermetic stock items have been proved to MIL-T-27A, eliminating costs and delays of initial MIL-T-27A testing.

HERMETIC SUB-MINIATURE AUDIO UNITS

The smallest hermetic audios made (except our DO-T's, for transistor use)

Dimensions . . . ½ x 11/16 x 29/32 . . . Weight, 8 oz.

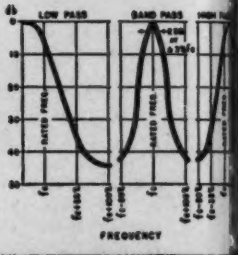
TYPICAL ITEMS

Type No.	Application	MIL Type	Pri. Imp. Ohms	Sec. Imp. Ohms	DC in Pri MA	Response ±2 db (Cyc.)	Max. level dbm
H-31	Single plate to single grid, 3:1	TF1A15YY	10,000	90,000	0	300-10,000	+13
H-32	Single plate to line	TF1A13YY	10,000****	200	3	300-10,000	+13
H-33	Single plate to low impedance	TF1A13YY	30,000	50	1	300-10,000	+15
H-35	Reactor	TF1A20YY	100 Henries-0 DC, 50 Henries-1 Ma. DC, 4,400 ohms.				
H-36	Transistor Interstage	TF1A15YY	25,000	1,000	.5	300-10,000	+10
H-37A	Transistor Output	TF1A15YY	500 CT (DCR50)	50 (DCR5)	3.5	300-10,000	+15
H-40A	Transistor Output	TF4RX17YY	500 CT (DCR26)	600 CT	10	300-10,000	+15

*Can be used for higher source impedance, with some reduction in frequency range.

COMPACT HERMETIC AUDIO FILTERS

UTC standardized filters are for low pass, high pass a band pass application in both interstage and line i pedance designs. Forty-five stock values, others to der. Case 1-3/16 x 1-11/16 x 1⅜ – 2½ high . Weight 6-9 oz.



OUNCER (WIDE RANGE) AUDIO UNITS

Standard of the industry for 18 years, these units provide 30-20,000 cycle response in a case ⅞ dia. x 1-3/16 high. Weight 1 oz.

TYPICAL ITEMS

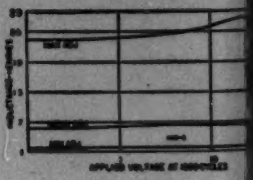
Type No.	Application	Pri. Imp.	Sec. Imp.
O-1	Mike, pickup or line to 1 grid	50, 200/250, 500/600	50,000
O-2	Mike, pickup or line to 2 grids	50, 200/250, 500/600	50,000
O-3	Dynamic mike to 1 grid	7.5/30	50,000
O-7	Single plate to 2 grids, D.C. in Pri.	15,000	95,000
O-9	Single plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600
O-10	Push-pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600
O-12	Mixing and Matching	50, 200/250	50, 200/250, 500/600
O-15	10:1 single plate to 1 grid	15,000	1 megohm
O-20	Transistor to line	1,500 CT	500/125 (split)

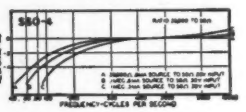
HERMETIC VARIABLE INDUCTORS

These inductors provide high Q from 50 - 10,000 cycles with exceptional stability. Wide inductance range, (10 - 1) in an extremely compact case 25/32 x 1-1/8 x 1-3/16 . . . Weight 2 oz.

TYPICAL ITEMS

TYPE No.	Min. Hys.	Mean Hys.	Max. Hys.	DC	Ma
HVC-1	.002	.006	.02	100	
HVC-3	.011	.040	.11	40	
HVC-5	.07	.25	.7	20	
HVC-6	.2	.8	2	15	
HVC-10	7.0	25	70	3.5	
HVC-12	50	150	500	1.5	





SUB-SUBOUNCER AUDIO UNITS

UTC Subouncer and sub-subouncer units provide exceptional efficiency and frequency range in miniature size. Constructional details assure maximum reliability. SSO units are 7/16 x ¾ x 43/64 . . . Weight ⅓ oz.

TYPICAL ITEMS

Type	Application	Level	Pri. Imp.	MA D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	3700
SSO-2	Interstage /3:1	+ 4 V.U.	10,000	0-.25	90,000	750	3250
*SSO-3	Plate to Line	+20 V.U.	10,000 25,000	3 1.5	200 500	2600	35
SSO-4	Output	+20 V.U.	30,000	1.0	50	2875	4.6
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.						
SSO-6	Output	+20 V.U.	100,000	.5	60	4700	3.3
*SSO-7	Transistor Interstage	+10 V.U.	20,000 30,000	.5 .5	800 1,200	850	125

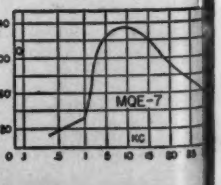
*Impedance ratio is fixed 1:1250 for SSO-1, 50:1 for SSO-3. Any impedance between the values shown may be employed.

HERMETIC MINIATU HIGH-Q TOROIDS

MQE units provide high Q, excellent bility and minimum hum pickup in a only. ½ x 1-1/16 x 17/32 . . . w 1.5 oz. MIL type TF4RX20YY.

TYPICAL ITEMS

Type No.	Inductance	DC Max.
MQE-2	12 mhy.	100
MQE-4	30 mhy.	65
MQE-7	100 mhy.	35
MQE-9	.25 hy.	22
MQE-11	.6 hy.	14
MQE-13	1.5 hy.	9
MQE-15	2.8 hy.	7.2



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electronics engineering edition

A McGRAW-HILL PUBLICATION • VOL. 31 • NO. 1 • JANUARY 3, 1958

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Nominal Performance Characteristics of Typical SPRAGUE Magnetic Shift Registers

OPERATING FREQUENCY									
Maximum (kc)	0-25			0-100			0-200		
Recommended (kc)	0-20			0-90			0-190		
VOLTAGE SIGNAL LEVEL	4	15	30	4	15	30	4	15	30
SHIFT PULSE									
Nominal Operating Current (ma)	160	160	160	140	200	200	220	220	220
Voltage Drop per Stage (v)	3.4	8.0	9.5	8.0	10.0	13.5	6.8	6.0	9.5
Duration (μsec at ½ amplitude)	7.0	6.5	5.8	2.0	2.0	2.5	1.2	1.2	1.2
Rise Time (μsec)	1.8	1.8	1.8	0.8	0.8	0.8	0.3	0.3	0.3
Fall Time (μsec)	0.9	1.8	0.9	0.8	0.8	0.8	0.3	0.3	0.3
Peak Pulse Power (watts)	.55	1.5	1.6	1.12	2.0	2.7	1.5	1.4	2.1
INPUT PULSE									
Amplitude (ma)	15	10	5	15	10	15	15	10	10
Duration (μsec)	10	10	10	3	3	3	2	2	2
PARALLEL OUTPUT PULSE									
Amplitude (ma)	4	16	32	5	18	30	4.5	16	30
Ratio (min.)	10:1	10:1	10:1	10:1	10:1	10:1	8:1	8:1	8:1
Load Impedance (ohms, min.)	2000	6000	25,000	1800	8000	15,000	10,000	10,000	18,000
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core-diode type magnetic shift register assemblies

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Wherever you use Sprague Magnetic Shift Register Assemblies . . . in the air or on the ground . . . in counters for industrial controls or basic logic circuits for computers . . . chances are you'll be looking for uniformity *and* reliability. That's why Sprague uses truly reliable components throughout their construction. Why every core used is subjected to rigid switching tests before installation. And why every assembly is 100% pulse performance tested before shipment.

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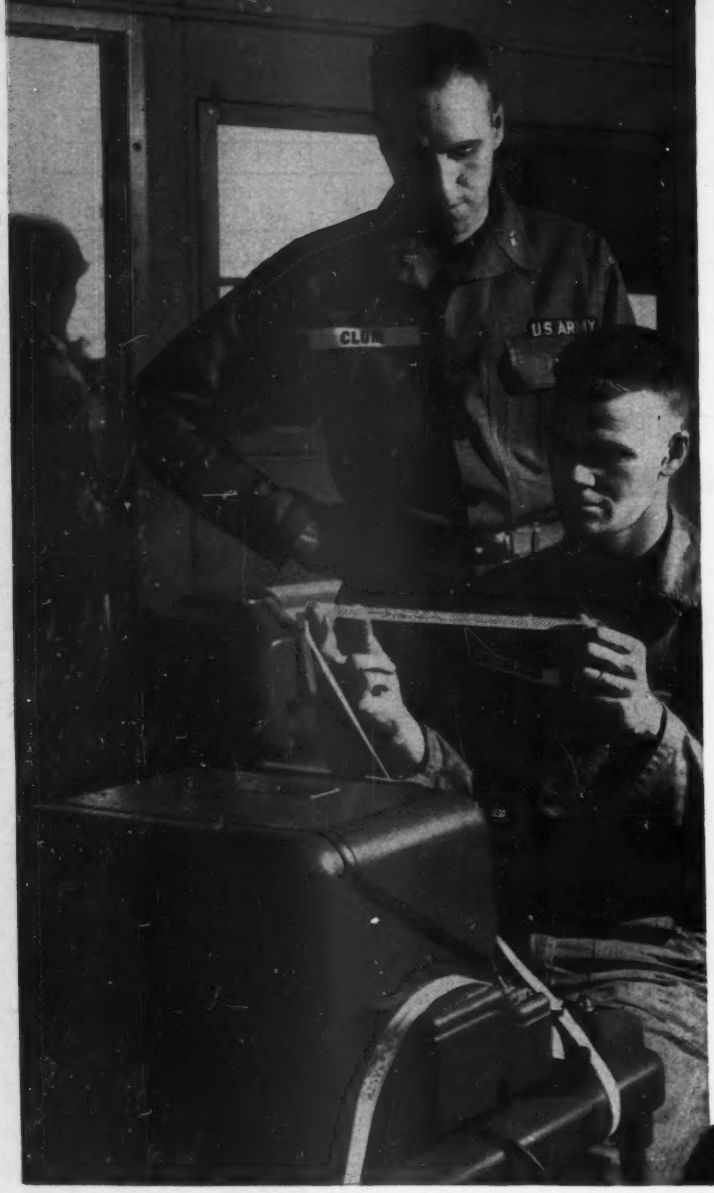
teleprinted messages sent, relayed and received...in seconds!



To coordinate the action of widely-dispersed groups, Kleinschmidt reperforator teletypewriters at communication centers immediately re-transmit printed messages to headquarters, exactly as received from outlying positions.

Reception and transmission of information to higher echelons must proceed smoothly, accurately and quickly. Kleinschmidt reperforator teletypewriters, developed in cooperation with the U.S. Army Signal Corps, save valuable time because the printed message on perforated tape facilitates fast reading...immediate action. The same tape activates the transmitting equipment; the original message reaches its ultimate destination without delay, without change.

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NEWLY DESIGNED FOR TRANSISTOR VOLTAGES

• 3 RANGES—FINE RESOLUTION • TUBELESS
• LOW COST • CONTINUOUSLY VARIABLE

These new T-Nobatrons are the perfect solution to the problem of providing well-regulated voltages for the development and testing of transistor circuits. They provide stable DC output voltages in three ranges, with fine resolution. Excellent transient response for line and load pulses. Simple tubeless construction means greater reliability, lower cost, Also ideal for many other applications in these voltage ranges, such as relay testing and computer circuitry development.

• DUAL RACK INSTALLATION

ELECTRICAL CHARACTERISTICS

Model	T50-1.5	T60-5	T120-2.5
AC Input (60 ~ , 1ϕ)	95-130	95-130	95-130
DC Output Voltage	0-10	0-10	0-25
(three ranges)	0-25	0-25	0-50
	0-50	0-60	0-120
Output Current (amps.)	0-1.5	0-5	0-2.5
Regulation, line: 105-125 V	±1%	±0.5%	±0.5%
For wider input	±2%	±1.0%	±1%
Internal Resistance, typical (ohms)			
low-voltage range	1.2	0.35	1.3
middle range	2.1	0.55	2.0
high range	4.5	1.0	4.0
Ripple (mv)	50 max.	50 max.	50 max.
Time Constant (line)	0.08 sec.	0.08 sec.	0.08 sec.
(load)	0.15 sec.	0.15 sec.	0.15 sec.

MODEL T50-1.5

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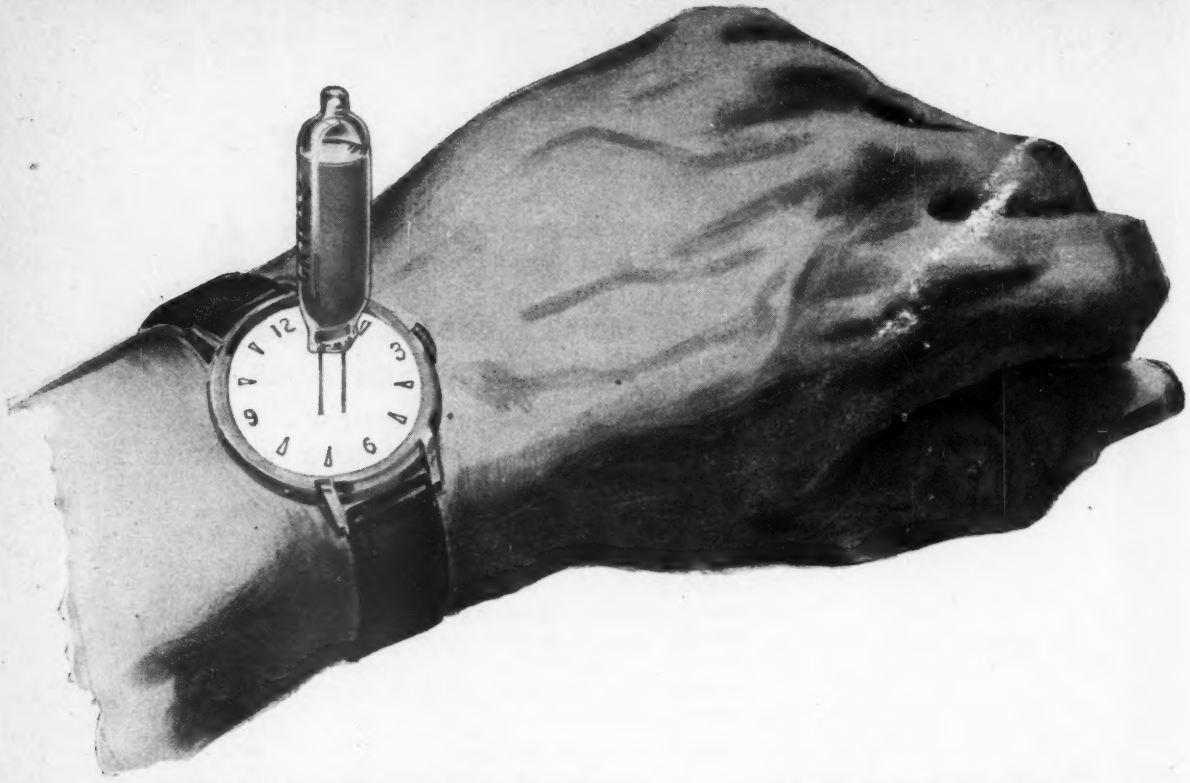
The tube that tells time



RAYTHEON'S new CK1053

Operating Time Indicator Tube:

- ✓ full scale time indication at any value from 250 to 5000 hours.
- ✓ operating ambient temperature: 0°C to 100°C.
- ✓ storage ambient temperature: −60°C to +100°C.
- ✓ current drain: 1 to 100 μAdc.
- ✓ voltage drop: approximately 2 volts.
- ✓ can be mounted in any position; wired into modules or subchassis; immersed in oil or any other medium.
- ✓ low cost, light weight, small size.

There's an almost unlimited range of applications for this revolutionary new Time Indicator which is read with a commercially available colorimeter. For the whole story get in touch with

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ELECTRONICS NEWSLETTER

● **Bigger** defense budget than the $38-billion one expected and more money for missile electronics could well be in the offing. Congressional leaders are preparing to achieve this through more bipartisan cooperation in budget considerations and voting this year.

That would pretty much mean granting the Administration's defense appropriation requests in full, perhaps even increasing them. **Some Congressional leaders feel the budget may go as high as $40 billion, with maybe close to $4 billion for electronics, including I & D.**

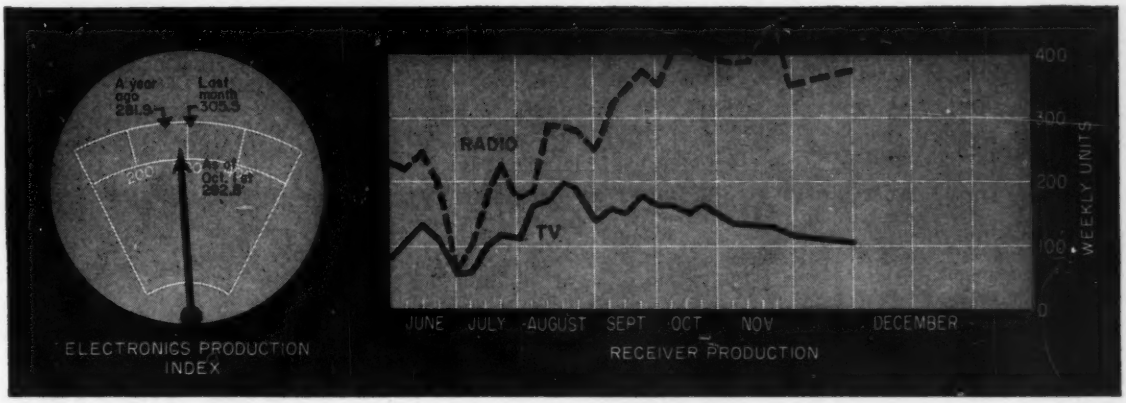
● **Missile spending,** already at a $4.5-billion annual rate, may go higher. Even before last month's successful test firing of the 5,000-mi Atlas ICBM, Missile Director Holaday told a Senate subcommittee that annual appropriations for this missile would have to be hiked by one-third. Subsequently Air Secy. Douglas revealed that we plan to have operational ICBM's "within two years."

Cost of one ICBM is estimated at $2 million, an IRBM at $1-$1.5 million, when they come off the production line. One-fourth goes for electronics.

● **Economic paradox** this year may be continued gains for our industry, even if the general business forecasts get gloomier. Sales of electronic products in 1957 rose to more than $7 billion from $5.9 billion in 1956. Electronic Industries Association looks for an 8 to 10-percent increase this year.

● **Radio set** output in 1957 was 9 percent above the previous year and "near post-war peaks." Continuing upward trend is predicted by EIA. Rising interest pushed production of these units from 13.9 million in 1956 to 15.3 million units in 1957. EIA thinks this figure will go up at least another half million in 1958.

FIGURES OF THE WEEK



RECEIVER PRODUCTION

(Source: EIA)	Dec. 7, '57	Nov. 29, '57	Dec. 7, '56
Television sets, total	109,339	123,844	151,993
Radio sets, total	387,597	357,881	374,826
Auto sets	121,784	109,372	164,907

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Latest Week Dec. 18, '57	Previous Week Dec. 11, '57	Year Ago Dec. 18, '56
Radio-tv & electronics ..	40.10	43.07	48.37
Radio broadcasters	50.09	52.88	62.05

LATEST MONTHLY FIGURES

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Aug. '57	July '57	Aug. '56
Prod. workers, comm. equip.	409,800-p	393,700-r	392,300
Av. wkly. earnings, comm.	$77.81 -p	$75.85 -r	$75.76
Av. wkly. earnings, radio	$75.81 -p	$75.24 -r	$73.75
Av. wkly. hours, comm. ..	39.9 -p	39.1 -r	40.3
Av. wkly. hours, radio ...	39.9 -p	39.6 -r	40.3

TRANSISTOR SALES

(Source: EIA)	Oct. '57	Sept. '57	Oct. '56
Unit sales	3,544,000	3,231,000	1,290,000
Value	$7,075,000	$6,993,000	$3,930,000

TUBE SALES

(Source: EIA)	Oct. '57	Sept. '57	Oct. '56
Receiving tubes, units ..	47,075,000	44,382,000	42,921,000
Receiving tubes, value ..	$38,421,000	$35,545,000	$34,362,000
Picture tubes, units	995,629	1,071,662	1,165,740
Picture tubes, value	$19,495,574	$20,819,036	$21,117,261

FIGURES OF THE YEAR

Totals for first 10 months

	1957	1956	Percent Change
Receiving tube sales	388,738,000	390,357,000	−0.4
Transistor production	22,386,300	9,403,000	+138.1
Cathode-ray tube sales.....	8,304,181	9,233,780	−10.1
Television set production....	5,251,158	6,050,052	−13.2
Radio set production.....	11,945,534	10,884,760	+9.7

Handwriting reader. Operator writes numerals with stylus on special surface at right

Push Computer Input, Storage

A NEW ALL-OUT, industry-wide attack is underway on the old computer bugaboos—input and access times.

Lecturers and exhibitors at the recent Eastern Joint Computer Conference in Washington, D. C. hammered away at input mechanization, memory expansion and data-retrieval speeds.

Also given attention was the development of hybrid or digital-analog computers. Activity in this area was marked by discussion and display of digital-to-analog and analog-to-digital conversion devices.

Other new developments include:

High-Density Drum – Memory designed by Laboratory for Electronics provides 14.7-megabit capacity with an average random access time of 180 milliseconds. Unique head construction permits 1,040-bit per inch storage on each drum track. Mechanical problems are partially overcome by hydrodynamically suspending read-write head on a thin film of low viscosity oil.

Handwriting Reader—Bell Lab introduced a reader (see photo) used to transfer handwritten numerals directly to data-processing devices. Information is inserted by writing on cards with a conductive pencil lead or writing on a special surface with a metal stylus. All numbers are formed around two vertical dots on the card or on the

WASHINGTON OUTLOOK

EXPECT MORE confusion out of Washington on the missiles picture.

The administration's position is confused by interservice rivalry, by the surplus of high-ranking officials with varying degrees of authority, by the pressures of politics.

The Democrats in Congress are powerful in saying how far and how fast our "catch-up-with-the-Russians" projects should go. They feel Eisenhower's prestige as a leader is badly tarnished, that they can now attack with vigor without risking political retaliation from constituents. In general, they're strong for more spending and a large-scale Pentagon shakeup.

Regardless of all this, electronics is sure to benefit from the huge new demand for more advanced weapons more quickly. The administration will have in its forthcoming budget more money for advanced weapons of all kinds—missiles, antimissile missiles, new radar warning nets, more submarines. There will be no cutbacks in bomber production, at least for a while, although output of other manned planes will be slashed.

All this means an increase in electronics business of substantial size. Pentagon spending for such gear during the fiscal year beginning July 1 will rise above the $3.5 billion to $4 billion to be spent this year.

The administration is already spending $4.5 billion yearly on missiles, an increase of $2 billion over the previous spending rate. Electronics share of guided-missile spending ranges from 25 percent for inertially guided ballistic types to 40 percent or more for other systems.

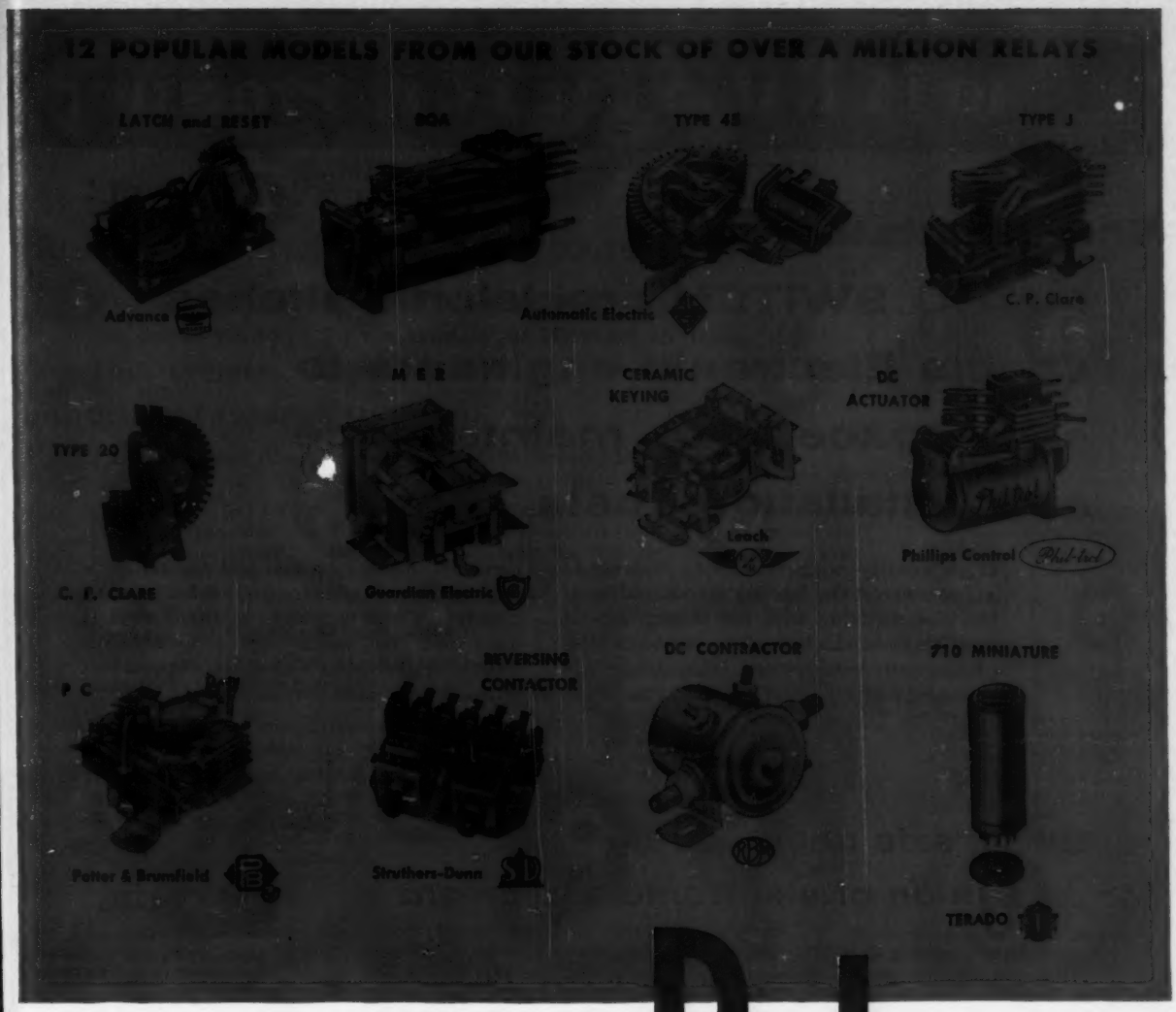
• **Missile production** is the number one target of the administration. The decision at this time is to get as many experimental IRBM's and ICBM's into production as soon as possible—Thor and Jupiter IRBM's, Atlas and Titan ICBM's. But contractors complain they see no evidence of production orders worthy of the name. Actually, missile-per-month production goals have been cut back. For instance, the goal now is to reach a Thor production rate of six a month sometime this year; earlier, there had been a tentative plan to produce twice as many.

• **Federal subsidies** for science education are sure to run into the hundreds of millions next year. The administration is expected to ask for a massive program calling for money to be paid to high schools, technical institutes and universities. This will go for scholarships, boosting pay of teachers, purchase of lab equipment. Administration officials are talking of $300 million per year; Democrats talk of $500 million per year. All the sciences, including mathematics and languages, would be involved.

Other proposals range far and wide: A federal science academy similar to West Point, Annapolis, and the new Air Force Academy; a new government agency responsible for exploring outer space as the Atomic Energy Commission is for nuclear projects.

No one knows for sure how far any of these ideas will eventually go. But one thing is sure: electronics projects, whether government or privately sponsored, have a chance for acceptance by Washington that's far greater than ever before in our history.

One sign: bickering over raising pay of government scientists and engineers is over. The administration will back its own ideas which would boost the salaries of top pay-grade scientists and engineers by as much as $1,000 a year.



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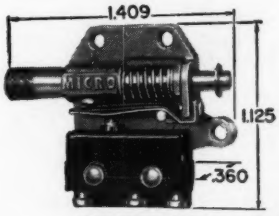
High quality with reliability has made MICRO SWITCH the leading manufacturer of precision switches with the largest line of switches from which to select. MICRO SWITCH plants and development laboratories are equipped with scientific tools for painstaking precision, quality control and testing techniques. Field Engineering offices blanket the country. There is always a MICRO SWITCH man near you—ready to cooperate on switching problems. Consultation costs you nothing—can save you much.

Small, safe door interlocks for protection of electronic equipment



MICRO SWITCH subminiature door interlock switch assembly.

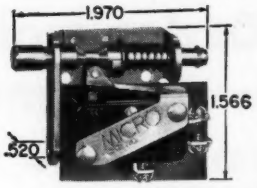
These MICRO SWITCH door interlock assemblies are for use on cabinets housing hazardous equipment—such as radio, radar, x-ray, etc. The interlock automatically cuts off the power supply when the door is opened.

By pulling the rod actuator to the maintained contact position, it is possible for service personnel to check the circuits with the power on.

When the door is closed, the rod automatically returns to the normal position so that the next door opening will automatically break the circuit. This eliminates the danger involved in "tying down" conventional door interlocks.

Interlock-assemblies shown are but two of over 70 such assemblies available with subminiature, V-3 type switches and other basic switches.

(Send for Catalogs 74 and 75)



MICRO SWITCH V-3 door interlock switch assembly.

This screwdriver-operated switch saves wiring and panel space

This subminiature switch assembly is operated by 90° turn of a screwdriver

Here is an ideal switch for locations to which access is limited and where it is desirable to prevent accidental operation. Designers have found it particularly suited to such applications as computers, electrical devices and electronic equipment.

The switch is operated by a 90-degree turn of a screwdriver. The slotted head gives visual indication of the position of the switch. Because this switch can be mounted deep in equipment, either on or below the chassis, it saves wiring cost and valuable panel space. All that is necessary for its operation is an access hole and a long screwdriver.

(Send for Data Sheet 115)

Switches have uses unlimited

How to get more pushbutton switches on a panel

MICRO SWITCH Series 100 PB Lighted Pushbutton Switches provide an unusually neat, good looking panel. Their compact mounting allows more switches per panel.

Important features include:

Three types of illuminated signal—

(1) one-color buttons, (2) two colors (lighted singly or in combination) and (3) choice of either of two colors—neither of which is visible when button is unlighted.

Large, easily engraved buttons—

Buttons are large enough to allow two lines of clearly legible engraving.

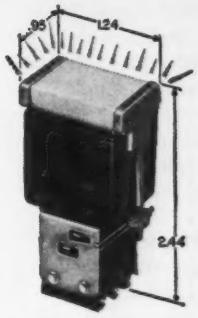
Wide choice of circuitry—

Because separate terminals are provided for each lamp and for each element of the contact structure, these switches permit intermixing of voltages, a-c or d-c current and even combinations of opposing polarities.

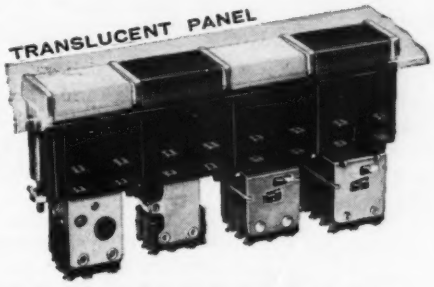
Matching lamp assemblies available—

Matching indicating lamp assemblies are available with the same button and lamp combinations and the same means of mounting as the complete 100 PB switch assembly.

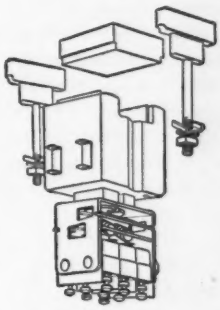
(Send for Data Sheet 143)



Typical switch module on a 3-circuit design.

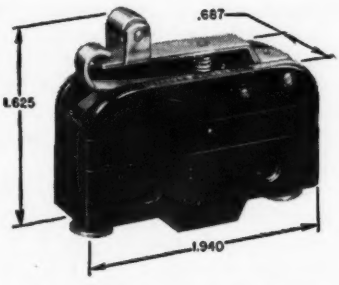


A typical compact assembly of switches in panel slots. Indicates choice of button color and number of circuits.



Exploded view showing switch assembly, button and mounting means.

A roller-lever switch with the stability of pin-plunger switch



A new design in roller-lever actuators is this MICRO SWITCH Type W.

This small, compact roller-lever basic switch is ideal for use of such control mechanisms as radar units, precision machine tools or other devices where precise actuation with little variance in operating points is required.

This Type W switch incorporates a new design in roller lever actuators which gives it an operating stability similar to a pin-plunger switch—low pre-travel, narrow differential travel and close repeatability but also permits exceptionally high overtravel.

The roller is located on top of a double lever. As the roller is depressed, both levers move downward until the switch is actuated. The upper level then proceeds on downward, providing the high overtravel. The limited overtravel given to the snap spring and a low break gives this switch a long, trouble-free mechanical life.

(Send for Data Sheet 127)

MICRO SWITCH

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First in Precision Switching

surface. Shape of character drawn is sensed when radius vectors extending from the dots have been crossed. Rapid processing of long distance tickets is the first use Bell expects to make of the reader.

High-Speed Punch—Soroban Engineering demonstrated their 240-word per second tape perforator designed to supply 5, 6, 7 or 8-hole input data to communications equipment. The punch will also complement instrumentation systems and record computer output data.

Magnetostrictive Memory—A magnetostrictive delay-line memory unit capable of 120-microsecond random access and large storage capacity was displayed by Deltime. One delay line is used to generate clock pulses and to form digits while ten other delay lines serve as storage devices.

Converter—Packard-Bell introduced a transistorized, voltage-to-digital and digital-to-voltage conversion system. The packaged unit, called a Multiverter, is also capable of performing interstage arithmetic operations. Analog-to-digital conversion time is 4 microseconds per bit for 0.01-percent accuracy. Digital-to-analog conversion time is 4.5 microseconds.

Tape Reader—Digitronics' perforated tape reader is capable of reading either paper strips or reels at 750 characters per second. Reverse feed control permits operation for programs requiring repeat feeding. Unit was designed for use with digital computers and automation controllers but can also convert data from perforated tape to magnetic tape.

Spectrometers In Production

TIME-OF-FLIGHT mass spectrometers are now in commercial production at Bendix Aviation's Cincinnati division. They carry price tags of $15,000 to $25,000. Their stock in trade is almost instantaneous analysis.

The instrument uses radar-like techniques to reveal the molecular mass of matter under study. It can analyze vaporized gases, liquids or solids as quickly as 1/10,000th second.

MILITARY ELECTRONICS

• **Newly-formed System Development Corp.,** formerly a division of Rand Corp., will take over from Rand a $20-million contract with USAF which calls for providing professional technical services to the Air Defense Command.

Two major projects are: installation and maintenance of a system training program for the air defense system, and programming for the computers in SAGE.

• **Inertial guidance system for Thor,** according to producer AC Spark Plug, is sufficiently accurate to take a plane from Milwaukee to a predetermined runway in Los Angeles without the pilot's touching the controls. "Volume production" has been ordered for Thor.

• **Electronic training device** called the Universal Simulator trains Navy personnel at the U. S. Submarine Base at Groton, Conn., for work on nuclear-powered subs. Engineering specifications for the simulator were provided by the Naval Training Device Center. Electric Boat division of General Dynamics was in charge of production.

By adjustment of its computer system, the simulator can be made to duplicate the control characteristics of all the various types of submarines now in action, plus a few still on drawing boards.

• **Electronically-operated device** to count and measure fog particles has been developed by the Army Chemical Corp's Chemical Warfare Laboratories, Army Chemical Center, Md. Expected to be useful in studies of chemical fogs and other fine particle matter, the device distinguishes between droplets of moisture and other kinds of particles. One man can measure and record an average rate of 3,300 particles an hour.

Masers Probe Outer Space

A THREE-LEVEL solid-state Maser, operated at Harvard last month for the first time, promises to extend the range of radio telescopes 10 times farther out among the galaxies and should be able to confirm or deny the existence of hydrogen gas between the galaxies, now only suspected.

This Maser was the first to run successfully in the 21-cm wavelength band—the frequency emission from interstellar hydrogen.

Another significance of the device, which provides amplification by redistributing the magnetic moments of the electrons inside a crystal, lies in its signal-to-noise ratio. It is believed that the Harvard Maser, a low-noise amplifier with a moderately high gain, will allow detection of signals one one-thousandth as strong as can be observed now.

The immediate application is to radio astronomy. The narrow band width may make it unsuitable for some radar applications, say J. O. Artman and Sydney Shapiro of Harvard, but it is expected to aid radar systems development.

Heart of Harvard's Maser is single crystal of potassium cobalticyanide, with an intentionally introduced impurity of one-half of present potassium chromicyanide. The crystal, about the size of the last joint of a man's thumb, is kept by a bath of liquid helium at two degrees Kelvin.

Electrons of the impurity in three discrete energy levels are used. Amplification is gained by shifting electrons from level to level within the crystal.

An applied electromagnetic field pumps the electrons continually from the lowest to the highest three energy levels. By keeping the crystal cold, the "relaxation" time—the time it takes for downward jump to restore equilibrium—is lengthened, and a maximum number of electrons is kept at the

4237

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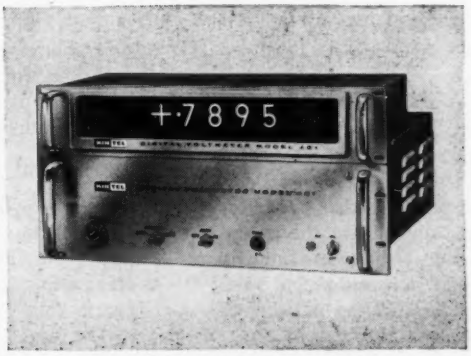
See the difference!

ORDINARY READOUT

KIN TEL READOUT



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- *100 Microvolt Sensitivity*
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- *High Reliability*
- *0.0001 to 999.9V—Plus Automatic Decimal and Polarity Indication*

SPECIFICATIONS

Display...Four (4) digit with automatic polarity indication and decimal placement. Total display area 2" high x 7.5" long, internally illuminated. Individual digits 1.25" high.

Automatic Ranges...0.0001 to 999.9 volts covered in four ranges.

Accuracy...0.01% or 1 digit, whichever is larger.

Counting Rate...30 counts per second, providing average balance (reading) time of 1 second, maximum balance time of less than 2 seconds.

Reference Voltage...Chopper-stabilized supply, referenced to an unsaturated mercury-cadmium standard cell.

Input Impedance...10 megohms, all ranges.

Output...Visual display, plus print control. Automatic print impulse when meter assumes balance. No accessories required to drive parallel input printers.

Input...115 volt, 60 cycle, single phase, approximately 75VA.

Dimensions...Control unit, 5¼" high x 19" wide x 16" deep. Readout display, 3½" high x 19" wide x 9" deep.

Weight...Approximately 40 lb.

Price...$2,100

Over 10,000 KIN TEL instruments in use today!

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highest level. And incoming impulse of 21-cm radiation stimulates emition from the top energy level. Its electrons drop to the middle energy level, emitting 21-cm radiation. They give for far more radiation than the incoming trigger signals. The net effect is that they amplify greatly the incoming signals.

Professor Thomas Gold, Harvard astronomer and authority on radio astronomy, says the Harvard College Observatory hopes to apply the Maser to the radio telescope as soon as possible. To make full use of it, declare Artman and Shapiro, a microwave circulator is needed—and this has not yet been developed as a packaged unit.

Professor Gold predicts the Maser will enable radio telescopes to reach out into the universe as far as, or farther than, the best optical instruments. Maser-equipped telescopes should provide a testing of cosmological theories (such as the theory of the expanding universe) "better than in every present means," he says.

The Maser was developed by Nicolas Bloembergen, Artman and Shapiro. Bloembergen, Gorden McKay Professor of Applied Physics, proposed the three-level solid state Maser in July 1956.

Testing Moon As Reflector

CONTROL of rockets traveling half way around the earth, and television transmissions to points located over half the globe, are among possibilities now being envisioned from research by the U. of Illinoi: and Army Signal Corps.

These things may be accomplished by using the moon as a giant reflector of radio signals.

Now the university and Army are engaged in a project studying the quality and reliability of these signals.

An antenna reflector 28 feet in diameter has been erected atop the Electrical Engineering Bldg. on the campus to receive signals coming by way of the moon from the Signal Corps Laboratory at Ft. Monmouth, N. J.

Radio signals make the half-million-mile round trip in 2½ sec.

FINANCIAL ROUNDUP

• **Midwestern Instruments,** Tulsa, Okla., purchases **Data Storage Devices,** Van Nuys, Calif. Purchase amount was not disclosed. DSD will be moved to Tulsa with about 10 executives. About 100 employees will be hired to staff the new division. DSD manufactures magnetic recording heads and memory drums. Midwestern makes components for military equipment, including missiles.

• **Control Data Corp.,** Minneapolis computer development firm, purchases **Cedar Engineering,** an electronics and precision manufacturing company, also of Minneapolis. All of Cedar stock was acquired but price was not disclosed. Purchased firm will become the Cedar Engineering Division of Control Data. This first step in a program of growth through acquisition adds production and engineering facilities to Control Data's research and development facilities.

• **Dumont-Airplane & Marine Instruments** of Clearfield, Pa., announces purchase of **Le John Manufacturing Co.,** Huntington, West Va. The purchase is part of Dumont's expansion and acquisition program. Le John produces electrical and mechanical equipment for the government, and fans, blowers and hair dryers for home and industry. Dumont makes capacitors and designs and manufactures electrical-electronic devices.

• **Federal Shock Mount** bought by **Massachusetts Mohair Plush,** through stock purchase. Both firms are located in New York City. Federal designs, develops and manufactures vibration and shock mountings for use in missile and aircraft equipment. Mass. Mohair operates textile mills and other industrial enterprises.

• **Martin Co.** in Baltimore, Md., is looking into merger possibilities with several aircraft firms and also several firms heavy in electronics and guidance. Martin's president, George M. Bunker, expects reduction in number of aircraft firms from trend toward complex weapon systems. He foresees mergers leading to fewer companies and wants Martin to be ahead of this movement.

• **Cohu Electronics,** San Diego, Calif., acquires **Millivac Instrument** and **Volkers & Shaffer,** both of Schenectady, N. Y. Acquisition was effected through exchange of stock, but price was not disclosed. The two acquired companies, which manufacture electronic instruments, will be merged into a single operating unit, the Millivac Division of Cohu. Transistor and tube patents held by Walter Volkers, former head of the acquired companies, were part of the merger deal. Volkers becomes president of the Millivac Division and Cohu vice-president.

Semiconductor Sales to Leap

SEMICONDUCTOR sales will increase to about $1 billion annually in 1967, according to a market analysis reported by H. Brainard Fancher, general manager of GE's Semiconductor Products Dept.

Transistors were used in about 12 percent of the new electronic equipment built in 1957. Their use is expected in about 80 percent of equipment to be built in 1967.

Fancher predicted that transistors will be instrumental in the expansion of the electronics industry from a total new equipment sales volume of $6.9 billion in 1957 to $12.5 billion in 1967.

Total semiconductor sales in 1957 are put at $140 million. A market of $200 million is expected in 1958. Of this, $105 million will be transistors. Transistors are expected to show a 75 percent rise in unit volume and a 50 percent rise in dollar volume. Sales of semiconductor diodes and rectifiers will increase about 25 percent during 1958.

Fancher expects semiconductor market growth to follow the pattern set by tubes. However, he points out, semiconductor devices are gaining about three times as fast as tubes.

The largest single future market could be tv receivers.

Hughes
Quick Recovery
Silicon Junction
Diodes

HIGH SPEED
HIGH TEMPERATURE
HIGH VOLTAGE

Now, in circuits where germanium once provided the only possibility, you can use quick recovery silicon diodes from Hughes. Speeds are fast enough for most high frequency or fast switching applications. And every diode is well able to stand up under high voltages at high temperatures. In fact, the breakdown voltage *increases* with temperature, thereby providing maximum protection when temperatures reach unexpected levels. This is real ruggedness, the kind that ensures reliability under the most severe operating conditions.

NEW HIGHER CONDUCTANCE TYPES — Here's a new group of related diodes, each with excellent voltage and temperature characteristics plus the added advantage of higher forward current.

*Special high conductance types are available in *all* voltage classes covered by the standard line.

SPECIFICATIONS *

Type Numbers	WIV (min.)	Forward Current @ 1.5V (min.)	Reverse Current at Specified Voltage @ 25°C (max.)	@ 100°C (max.)	Recovery (mod. IBM "Y" test circuit)
1N625	30V	4mA	1 μA @ −10V 10 μA @ −20V	50 μA @ −20V	15 KΩ (min.) in 0.15 μsec
1N626	50V	4mA	20 μA @ −35V	100 μA @ −35V	400 KΩ (min.) in 1 μsec
1N627	100V	4mA	20 μA @ −75V	100 μA @ −75V	400 KΩ (min) in 1 μsec
1N628	150V	4mA	20 μA @ −125V	100 μA @ −125V	400 KΩ (min.) in 1 μsec
1N629	200V	4mA	20 μA @ −175V	100 μA @ −175V	400 KΩ (min.) in 1 μsec
HD6573	150V	6mA	20 μA @ −125V	100 μA @ −125V	400 KΩ (min.) in 1 μsec
HD6635	50V	15mA	20 μA @ −35V	100 μA @ −35V	400 KΩ (min.) in 1 μsec
HD6641	150V	15mA	20 μA @ −125V	100 μA @ −125V	400 KΩ (min.) in 1 μsec
HD6642	50V	6mA	20 μA @ −35V	100 μA @ −35V	400 KΩ (min.) in 1 μsec

Ambient Operating Temperature Range: −80°C to +150°C

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Makes Radar's 'Missing Link'

DEVELOPMENT of a device which "sees" through fog, rain or snow was announced recently by Diamond Antenna and Microwave Corporation of Wakefield, Mass.

"Eyetron" converts microwaves into visible light, reproducing the vision of the human eye electronically, according to Albert S. Hovanessian, Diamond president.

The company claims Eyetron will permit safe landing of planes under zero visibility conditions. Other applications, the firm says, include "close navigation" for ships and harbor craft.

Eyetron is not radar, nor is its purpose to replace radar, says Hovanessian. "Our chief intention is to supply the 'missing link' of present-day radar systems; that is, to fill the gap where radar is useless at close proximities and where radar-type presentation requires skilled operators."

The company is withholding technical details of the device, says the military "has first call for its use."

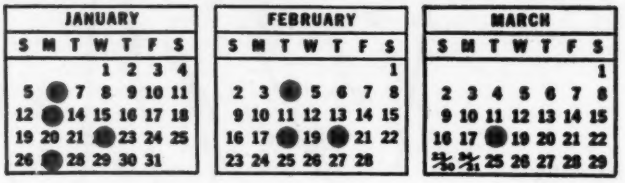
Fuel Gage Sales Hit $20 Million

CAPACITOR-TYPE electronic fuel gage systems are now used in almost all military and commercial planes. Private craft still generally employ mechanical floats, however.

Minimum price of fuel-gage system is about $300. Volume nationwide business is in excess of $20 million, annually, more than eighty percent of which is done with the military. At least four firms are active in the field.

Many electronic fuel gages now use transistors. One such system weighs only one-half pound. Recent improvements made on gage systems include a free-flooding-tank unit, which permits accurate measurement of tanks containing mixed grades of aircraft fuel, and a load-limit control, which automatically stops the fueling pump at some preset level. This control is said to reduce fueling time from fifteen to twenty percent, enable a crew to perform additional tasks during the operation.

MEETINGS AHEAD



Jan. 6-8: Fourth National Symposium on Reliability and Quality Control, Hotel Statler, Washington, D. C.

Jan. 13-15: American Management Assoc. Conf. on Product Planning, Top-management, R & D programs, Roosevelt Hotel, N. Y. C.

Jan. 20, 27; Feb. 3, 10, 17, 24: Lecture Series on Modern Communications, AIEE, IRE, Univ. of Penn., Philadelphia, Pa. Contact: S. Sharp, Franklin Inst., Phila., Pa.

Jan. 22-24: Electronic Industries Assoc. (formerly RETMA) 1958 Conference on Automation, Auditorium of Arizona State College, Tempe (Phoenix) Arizona.

Jan. 27: Four Corners District of A.S.T.M., technical sessions planned for New Mexico, Arizona, Utah and Colorado. Contact: J. L. Abbott, 1902 Richmond N. E., Albuquerque, New Mexico.

Jan. 27-28: Sixth Scintillation Counter Symposium, IRE, AIEE, AEC, NBS, Hotel Shoreham, Wash., D. C.

Feb. 3-7: American Institute of Electrical Engineers, Winter General Meeting, Hotel Statler, N. Y. C.

Feb. 14-15: Cleveland Electronics Conference, Fifth Annual, IRE, AIEE, ISA, CPS, Masonic Auditorium, Cleveland, Ohio.

Feb. 18: Fourteenth Annual Quality Control Clinic, Rochester Society for Quality Control, War Memorial, Rochester, N. Y.

Feb. 20-21: Conf. on Transistor and Solid State Circuits, PGCT, AIEE, Univ. of Penn., Phila., Pa.

Mar. 16-21: Nuclear Eng. & Science Congress, PGNS, EJC, ANS, Palmer House, Chicago, Ill.

Mar. 18-19: Conf. on Extremely High Temperatures, AFCRC, Air Force Cambridge Research Center, L. G. Hanscom Field, Bedford, Mass.

Ready To Record Satellite Passes

SCIENTISTS of the University of Illinois Observatory currently are ready to record passages of any satellites —American or Russian—which go through the heavens within radio range, declares Prof. George C. McVittie, head of the astronomy department.

Under direction of Prof. George W. Swenson Jr., a radio interferometer has been set up to receive 108-megacycle signals from the American satellite and make precise records of them.

Because of the higher frequency and expected weaker signals, this is a more difficult and complicated job than was reception and recording of signals from the two Russian satellites, both of which were tracked at Illinois.

The equipment used to record satellites' passages is being kept in readiness for any future Russian launchings. It includes a pair of crossed interferometers and a short-base interferometer to receive 40-megacycle signals, and a pair of crossed interferometers operating on 20 megacycles.

CIRCLE 10 READERS SERVICE CARD →

DATA SHEET

PHILLIPS

REMOVE AND FILE FOR REFERENCE

SERIES 33 SUB-MINIATURE RELAYS

"SNAP-ACTION" DESIGN FOR EXTREME RELIABILITY

Novel snap-over action of this switch eliminates the "floating-contact". High contact pressures, extremely rapid flight time, quick arc quenching, high impact and contact wipe are features accounting for its great reliability and unusually high contact ratings. Impact and wipe of the switch action, especially when combined with special contact materials, results in excellent low-level or "dry circuit" operation. Rapid flight time and arc quenching makes this type switch particularly good with the use of inductive loads. Heat-treated Beryllium copper switch springs are employed for longer fatigue-life running into several million operations. Large contact blades offer good heat dissipation for long contact life.

Remove and file for reference.

SERIES 33 ASSEMBLY FEATURES:

DC-33 relays are constructed to withstand destructive shock tests of more than 100 G's without mechanical damage, and high operative shock and vibration tests without contact chatter or opening.

Standard coil and contact rating, listed on reverse side, are conservative. Additional ratings are available for special requirements.

Temperature range for the standard unit is from −65° C to 125° C. Wider temperature ranges available on request.

Terminal header and enclosure are designed to meet military requirements of leakage to specifications MIL-R-5757 and MIL-R-25018. Insulation within enclosure is of high-temperature inorganic type, preventing contamination of contacts.

Addition of a high temperature full-wave bridge rectifier is possible by extending length of the relay body to 1.5 inches.

Provisions for mounting are extremely flexible. Rugged standard mounting flange of the encircling type permits placement of flange at any position along body length.

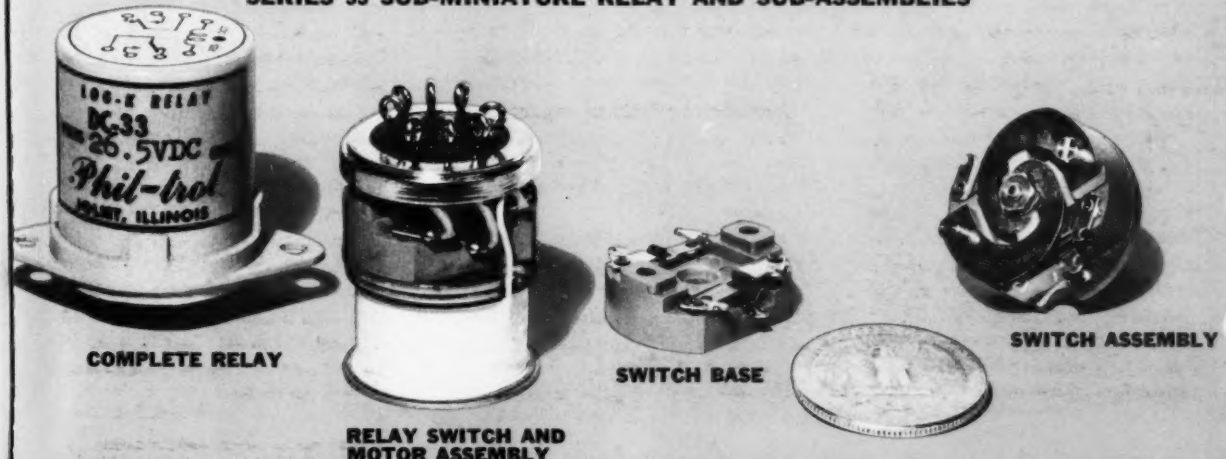
SERIES 33 DESIGN FEATURES:

THE MAGNETIC ASSEMBLY: High magnetic efficiency and unusually low magnetic leakage is a characteristic of this tightly-closed magnetic circuit. Fully annealed Armco iron is used. Favorable armature weight (2.2 grams) to retractable spring ratio accounts for high resistance to external forces. Special coil design—dry-wound without impregnating varnishes and a minimum amount of inorganic materials—provides a high number of ampere turns for greater magnetic efficiency. Freedom of residual magnetism is obtained without use of conventional non-magnetic anti-freeze pins.

DOUBLE SPIRAL SPRING: This unique spring functioning as the armature retraction and one armature bearing, was especially designed for non-resonance over a frequency range from 0 to more than 3500 cps. Composed of two adjacent sections, each of which are dissimilar and tapered by a logarithmic function, this spring cancels out small resonant conditions which tend to occur. Spring is flexible in only one plane, allowing good armature activity plus good armature stability from movement in undesireable planes.

Perforated for easy tear-out.

SERIES 33 SUB-MINIATURE RELAY AND SUB-ASSEMBLIES



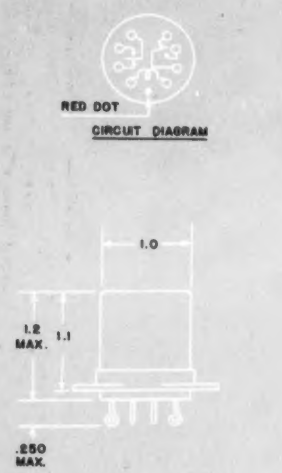
COMPLETE RELAY

RELAY SWITCH AND MOTOR ASSEMBLY

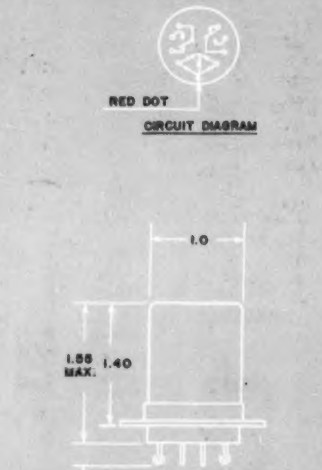
SWITCH BASE

SWITCH ASSEMBLY

Detailed Specifications — Phillips Sub-Miniature Relays



DC-33	CHARACTERISTICS	DC-33-AC
2 PDT Snap Action-(2 Form C)	*Contact Form	2 PDT Snap Action (2 Form C)
up to 200v. D.C.	Coil Voltage	up to 125v. A.C.
up to 12,500 ohms.	Coil Resistance	8,000 ohms.
50G, 11ms.	Shock (operating)	50G, 11 ms.
20G to 2,000c.p.s.	Vibration (operating)	20G to 2,000c.p.s.
−65°C to 125°C	Temperature Range	−65°C to 125°C
2.5 oz.	Weight	2.75 oz.
MIL-R-25018	Specifications	MIL-R-25018
Solder or 9 Pin Noval	Terminals	Solder or 9 Pin Noval
	DETAIL SPECIFICATIONS	
Standard Relay — available from stock		Standard Relay — available from stock
32	Max. Operating Voltage	125 A.C.
26.5	Nominal Coil Voltage	117 A.C.
18v. Max.	Pick-up Voltage @125°C	105v. A.C. Max.
13v. Max.	Drop-out Voltage @125°C	50v. A.C. Max.
275 ±10% ohms.	Coil Resistance @25°C	8,000 ±10% ohms.
Silver	Contact Material	Silver
5 amps.	Contact Rating, Resistive	5 amps.
100,000	Minimum Operating Life	100,000
Continuous	Rated Duty	Continuous
8ms.	Operate Time	10ms.
3ms.	Release Time	3ms.
.05 ohms Max.	Contact Resistance	.05 ohms Max.
1,000 Meg. Min.	Insulation Resistance	1,000 Meg. Min.
1,000 RMS	Voltage Insulation	1,000 RMS
	Operating Frequencies	60 to 400 c.p.s.



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JANUARY 3, 1958

Pill Telemeters From Digestive Tract

SUMMARY —— Radio sounding device, small enough to swallow and pass through the gastro-intestinal tract, generates 400-kc signals that transmit internal temperature and pressure information. Powdered iron core is pressure sensor while transistor base-collector resistance is temperature sensor. Receiver uses nonlinear capacitors to sweep frequency band

By STUART MacKAY and BERTIL JACOBSON
Karolinska Institutet, Stockholm, Sweden

SUCCESSFUL passage and operation of a radio telemetering device through the gastro-intestinal tract makes it possible to transmit internal temperature and pressure information, useful in medical diagnosis and physiological studies.

Transmitter

Called an endoradiosonde, the transmitter, modulator-transducer that is swallowed is a capsule that measures 0.9 cm in diameter and 2.8 cm long. Since much smaller components are becoming available, specific details will change. The typical circuit shown in Fig. 1, generates a sufficiently powerful signal so that it does not require the use of a shielded room. The common-emitter connection is used in a Hartley circuit with a tapped coil.

Components

The coil contains 600 turns on a hollow $\frac{1}{16}$ inch diameter form that is $\frac{1}{16}$ inch long. Into this moves a piece of powdered iron of $\frac{1}{4}$-inch length and turned down to $\frac{1}{8}$ inch in a lathe. The resonating capacitance is in the range of 100 $\mu\mu$f.

Best blocking action is obtained with Telefunken transistor OC 612 though the smaller CK 784 also was satisfactory. In some of the units, to save space, a hollow double capacitor was wound. Thin metal foil combined with 10-micron polystyrene tape, 5-mm wide, gives two

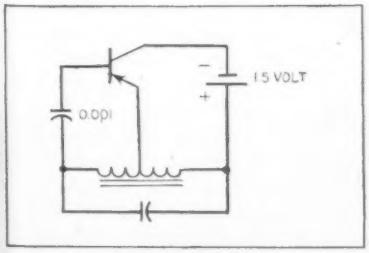


FIG. 1—Transistor quenching oscillator. The quench frequency depends on temperature and the r-f frequency on pressure. Adequate signal is generated to penetrate the body's attenuation

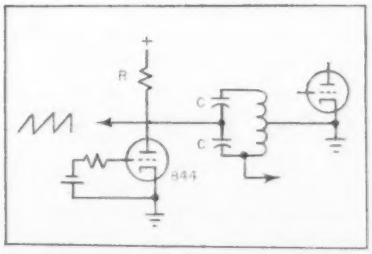


FIG. 2—Sweeping frequency oscillator based on properties of nonlinear capacitors. These act in series to tune the tank circuit and in parallel to generate the sawtooth to produce panoramic effect

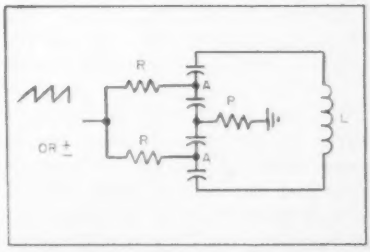
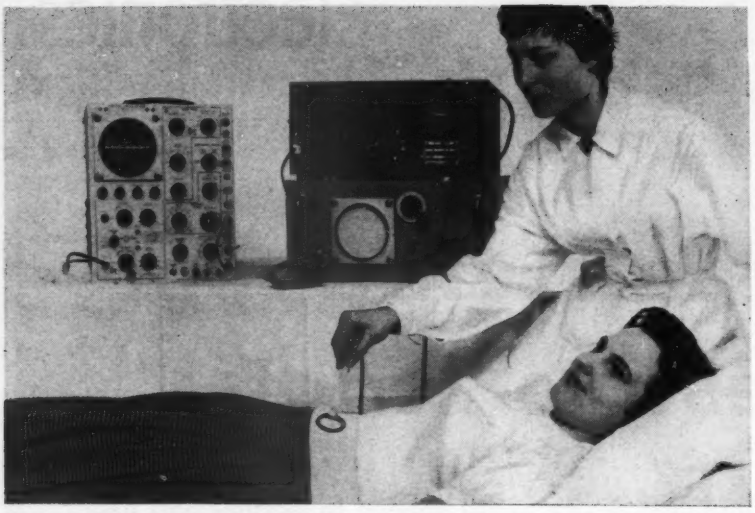


FIG. 3—Connection for many saturating capacitors under control of a small amplitude input sawtooth (or switches and a small direct voltage) and yet having small nonlinearity to the a-c of the tank



Nurse determining position of endoradiosonde. Signal is picked up by antenna loop connected to receiver. Oscilloscope at left gives temperature, right-hand scope gives pressure while drugs are tested as they progress through patient

cylindrical capacitors: a center piece with one metal piece outside and one inside, when the sandwich is wound up. The two capacitors of this unit required metal lengths of 5.5 centimeters and 0.55 cm.

The coil itself, is the transmitter antenna, its field being adequate for detection. Circuit components are sealed with Araldite.

Problems

The radio frequency, relatively insensitive to voltage changes, is affected by the shunt capacitance from end-to-end on the capsule. To eliminate the possibility of an air bubble giving an erroneous frequency shift, electrostatic shielding is desirable. Coating the inside with a layer of silver paint does not stop oscillation or radiation. An axial scratch eliminates any shorted turn effect.

These circuits are amplitude modulated if the iron core is replaced by a copper one. It should be noted that any point in these circuits can be grounded.

The diaphragm can be another source of error. A rubber membrane tends to change its elastic properties in various body fluids. To minimize this, the majority of the restoring force is supplied by a spring. An outer changeable limp diaphragm, employed for sanitary reasons, will also help.

It is desirable to eliminate the effects of orientation due to gravity acting on the core. A balanced pivoted armature is the obvious solution though a more compact method is desirable. The solution has not been found, but some methods for consideration are the use of a second internal weighted diaphragm at the other end of a U tube from the first, a second spring-suspended core at the other end of the coil, a spring suspending both core and coil and the use of a neutral buoyancy core in a liquid-filled chamber.

In some experiments, the battery consisted of an iron and a gold electrode with the subject's internal fluids acting as an electrolyte. For better stability the batteries are now constructed from the materials of a dismantled flashlight cell. The original batteries were formed around the lead from a pencil but the present ones sandwich the chemicals between flat sheets of zinc and carbon. Most of their volume is depolarizer.

During any normal experiment, 2-4 days, the battery voltage does not change. Radioactive batteries[2, 3] might be employed to give a longer life in a smaller space. If a radioactive transistor could be developed this would also help.

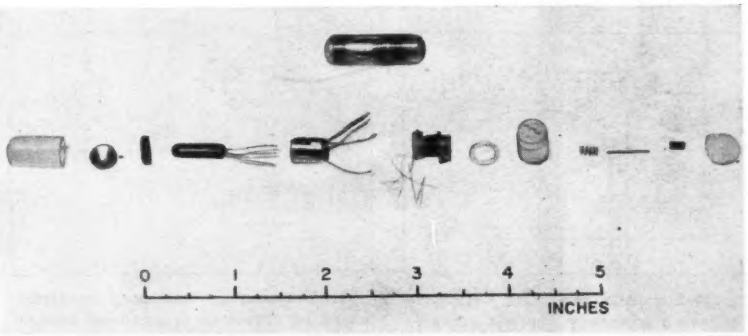
Frequency

Skin depth considerations and transistor performance limitations led to the choice of a 400-kc signal. This frequency is modulated by the motion of the iron core caused by pressure changes. The transistor is temperature sensitive and the pulse repetition rate of blocking transmits this temperature information. The latter reading, somewhat dependent on pressure, can always be corrected by the pressure reading which is relatively unambiguous.

Blocking Action

The blocking action depends on the charging of the base capacitor during oscillation because of rectification at the emitter junction. The base becomes positive. Due to oscillation hysteresis more charge is collected than is needed to keep the oscillation cut off and the transistor is biased off for a finite period. During this period the capacitor discharges through the temperature-sensitive resistances of the emitter and collector, both back-biased, in parallel.

Oscillation resumes after the base becomes a fraction of a volt negative with respect to the emit-



Assembled endoradiosonde above and disassembled unit below showing exploded view of components. Scale indicates relative size

ter. Since the collector resistance is usually lower than that of the emitter, the collector tends to dominate as a thermometer unless prevented from doing so. The period of this relaxation oscillation is proportional to the average of this resistance over the blocked part of the cycle, multiplied by the base capacitance.

If a ten-to-one turns ratio is used rather than approximately one-to-one then blocking is not observed, but instead amplitude modulation with temperature results due to the varying equilibrium voltage on the base capacitor.

The blocking frequency is sensitive to voltage as a first-order effect, decreasing voltage giving increasing frequency.

Receiver

The transmitted signal is received by a 100-turn loop, 4.5 cm in dia, connected to the input of a U. S. Army BC-348-P receiver. This size loop indicates the approximate location of the transmitter within the subject.

The receiver is tuned to indicate the pressure and the signal tone carries the temperature information. Transmitter coil and blocking capacitor are adjusted so that the radio-frequency bursts have an approximately flat envelope, which leads to relatively sharp tuning.

Scanning

In developing a scanning method for the radio frequency, as in a panoramic receiver, the circuit shown in Fig. 2 was evolved. The nonlinear capacitors C decrease their capacitance in response to the increasing direct voltage across each.[4] In series, they act as the tuning capacitor of the tank circuit. In parallel, they respond to the slowly increasing direct voltage. Thus nonlinearity to the radio frequency is small and sine waves are produced, but high control voltage is not required.

The scheme can be extended to four or more nonlinear capacitors as shown in Fig. 3. Here, one can either inject a sawtooth or apply steady d-c and periodically ground points A, in which case the circuit generates its own sawtooth.

High R lowers Q little but the replacement of parts of each R by inductance will make Q maximum. Some point on L is assumed to have a d-c ground. Because of their discharge in parallel, even small capacitors can trigger the thyratron, though a blocking oscillator is a better discharge device.

The oscillator tube is tapped down on the coil for somewhat increased circuit stability. The output sawtooth of the free-running circuit is for a horizontal sweep voltage while the a-c shown represents a local oscillator voltage.

Endoradiosonde, the transmitter-modulator-transducer that is swallowed, is a capsule 2.8 cm long and 0.9 cm in diameter

If the output of the radio is then used as a vertical oscilloscope signal, the frequency, in general, will not be a linear function of the signal position, but calibration is possible since there is a reproducible correlation between the two. Sweep in both directions gives a double signal due to one form of hysteresis observed in most nonlinear oscillatory systems.[5] Rather than cycling through the whole frequency band it is possible to use a related feedback arrangement to track the radio frequency either by maintaining a fixed frequency difference between the transmitted and local frequency or by cycling through a small range about the transmitted frequency. Feedback voltage then indicates pressure.

The transmitter is calibrated just before an experiment by applying known temperatures and pressures. Pressure sensitivity of the device can be checked within the subject by applying changing atmospheric pressure. Feedback, in which the output pressure reading is always returned to a fixed value by altering the surrounding pressure on the subject, is feasible for special observations. Calibration is then not necessary since linearity and sensitivity do not enter (to first orders). Observation would start at greater than atmospheric pressure in the capsule and on the subject. The subject in this case should be accustomed to sudden pressure changes (such as a skin diver). The required surrounding pressure then measures the internal pressure.

Further Applications

Experiments are in progress to incorporate chemical analysis into such devices.[5] Any chemical reaction which is accompanied by reversible mechanical expansion and contraction could be employed in conjunction with the pressure-sensitive device. Certain ion-exchangers swell and shrink, while other macromolecular compounds change their osmotic pressure, for changes in pH. Although the accuracy is low for such chemico-mechanical systems, their simplicity and reliability may make them useful for medical diagnosis.

The use of an antimony electrode as a low-impedance pH sensor should receive further attention, particularly if one can be used without becoming coated and still work while biased to prevent dissolution under all body conditions. A radioactive light source might allow the introduction of optical methods, and be much more effective than a phosphorescent one. An exposed transister will telemeter light intensity and with the above could be used as a photometric pH transmitter.

Invaluable help in construction by Lars Nordberg is acknoledged. This work was done while R. S. Mackey was on leave from the University of California on a Guggenheim Fellowship.

References

(1) R. S. Mackay and B. Jacobson, Endoradiosonde, *Nature*, June 15, 1957.
(2) *Radio and TV News*, p 160, May 1957.
(3) A. Thomas, Nuclear Batteries, *Nucleonics*, **13**, p 129, Nov. 1955.
(4) R. S. Mackay, Sinusoidal and Relaxation Oscillations Sustained by Nonlinear Reactances, *Jour Appl Phys* **24**, p 1,164, Sept. 1953.
(5) B. Jacobson and R. S. Mackay, A pH-Endoradiosonde, *Lancet*, p 1,224, June 15, 1957.

Wireless Microphone

SUMMARY —— Transistorized wireless microphone operating at 460 kc, establishes induction field around transmitter within usable area without exceeding FCC radiation field limitation. Normal speaking voice produces peak f-m deviation of about 10 kc when used in lecture halls and auditoriums. Fixed f-m superheterodyne receiver recovers audio signal and feeds public-address or speech amplifier

By G. FRANKLIN MONTGOMERY National Bureau of Standards, Washington, D. C.

WIRELESS MICROPHONES are useful in studio or lecture hall where the announcer or speaker must be able to move without being restricted by microphone cabling. The unit described here consists of a dynamic microphone with a self-contained wireless transmitter.

Applications

A fixed receiver, whose electrical output substitutes for the direct microphone output, is used to feed the public-address or speech preamplifier. Both the wireless microphone transmitter and the fixed receiver were originally developed for the main lecture auditorium at the National Bureau of Standards.

Wireless microphones commonly use vacuum-tube transmitters and usually operate on a frequency within the vhf band. Vacuum-tube power drain often limits transmitter battery life to several hours. In addition, a troublesome bar to vhf operation is the FCC requirement that the radiation from an unlicensed transmitter be limited to 15 microvolts/meter at a range of $\lambda/2\pi$, where λ represents wavelength.

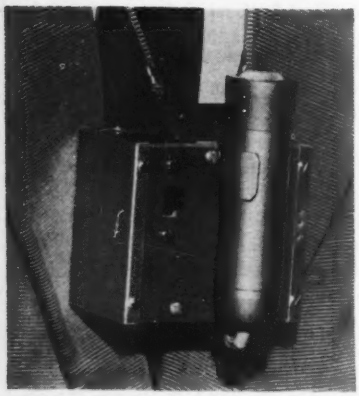
Specifications

For a moderate distance between transmitter and receiver, a signal with an adequate signal-to-noise ratio may be impossible to transmit without exceeding the FCC specification. The transmitter described in this article uses transistors to permit relatively long battery life and operates at 460 kc, a frequency at which an induction field can be established around the transmitter within a usable area without exceeding the radiation field limitation.

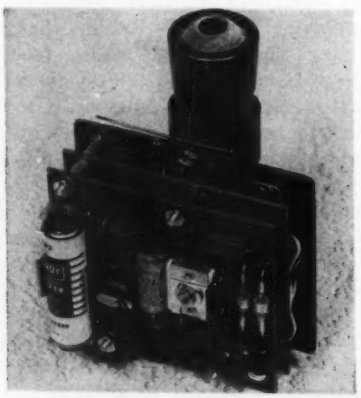
Transmitter

The transmitter circuit diagram is shown in Fig. 1. Frequency modulation was chosen principally because of its inherent automatic-volume-control action. The transmitter radiates a signal directly from the tank circuit which consists of coil L_1, wound on a ferrite rod.

The radiated power, determined by the transmitter coil current and its radiation resistance, is about



Wireless transmitter, worn as lavalier microphone, permits announcer to move freely in studio or lecture hall. Transmitter operation is controlled by switch



Interior view of transistorized microphone transmitter. Unit is compact and can be easily disassembled for repair through use of tier construction technique

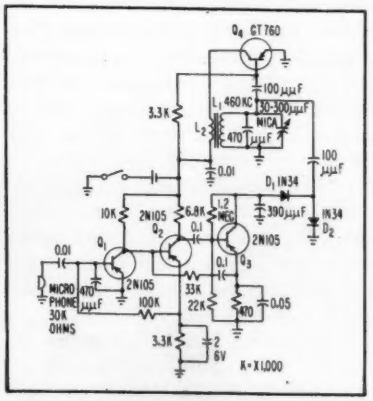


FIG. 1—Circuit for wireless microphone transmitter. Operating at about 500 kc, transmitter radiates about 2.2 × 10^{-13} watt directly from tank circuit

Uses F-M Modulation

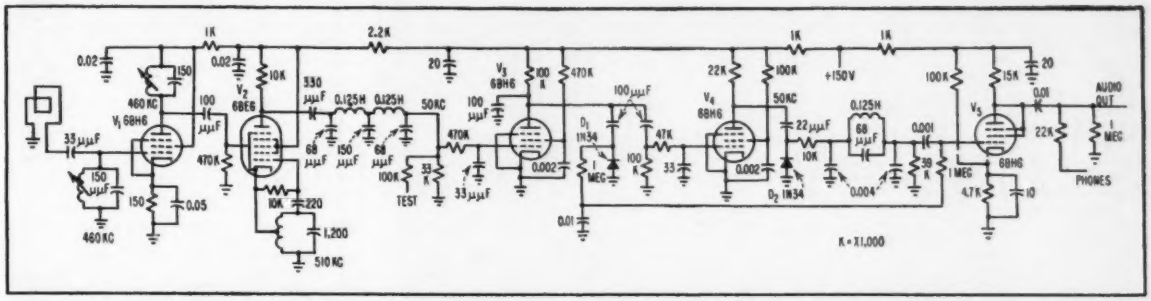
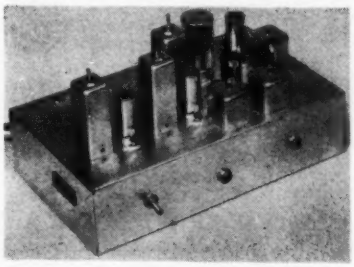


FIG. 2—Circuit for fixed receiver. Operating frequency of transmitter is converted to 50 kc by V_2 and is amplified and limited by V_3 and V_4. Audio signal is recovered after passing through low-pass filter. Peak audio output of receiver is about 0.5 volt



Fixed receiver for wireless microphone transmitter is vacuum-tube superheterodyne type

2.2×10^{-13} watt. Power is delivered to the tank by Q_1 operating as an oscillator at 460 kc.

Modulation

Diodes D_1 and D_2 control the r-f current through a 100-$\mu\mu$f capacitor shunted across the tank. The direct diode current is controlled by the audio-frequency current delivered to Q_2. A change in this direct current produces an approximately linear change in tank-circuit susceptance. The oscillator is therefore frequency modulated by the audio signal. Transistors Q_1 and Q_2 are audio-frequency amplifiers for the microphone output.

The coupling components were chosen to attenuate voice frequencies below about 700 cps. With the circuit shown, a normal speaking voice produces a peak deviation of about 10 kc. The total battery drain is about 15 milliamperes, so that with the single mercury cell the battery life is about 150 hours.

The vacuum-tube superheterodyne receiver is shown in Fig. 2. An r-f amplifier, V_1, operates at the signal frequency of 460 kc. Pentagrid converter, V_2, converts the signal frequency to 50 kc and the signal is amplified and limited by V_3 and V_4.

The output of stage V_4, a variable-frequency square wave, is differentiated and rectified by the counting-detector diode D_2. The audio signal is recovered by passing the diode output through a low-pass filter and amplified by V_5. Peak audio output is about 0.5 volt.

Receiver Unblocking

Squelch action is provided by diode D_1 which rectifies the received signal and unblocks the audio output stage during operation. This feature is useful in urban locations where the noise level is usually high.

The f-m superheterodyne receiver consumes little power and uses low plate and screen voltages consequently the operating temperature is low and the components should have long life.

Audio Response

The overall audio-frequency response of the system from microphone input to the receiver output is shown graphically in Fig. 3. No audio-gain control has been included in the transmitter but a control may be desirable to keep the deviation at maximum to compensate for differences in speakers.

The maximum size of the receiving loop depends on local noise field. A loop 5 meters square was used for this equipment. The loop could be made larger by using more transmitter power or by reducing

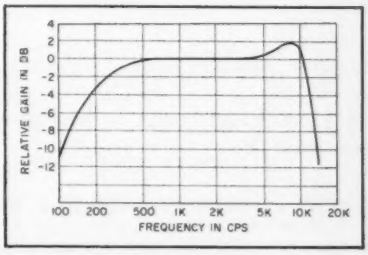
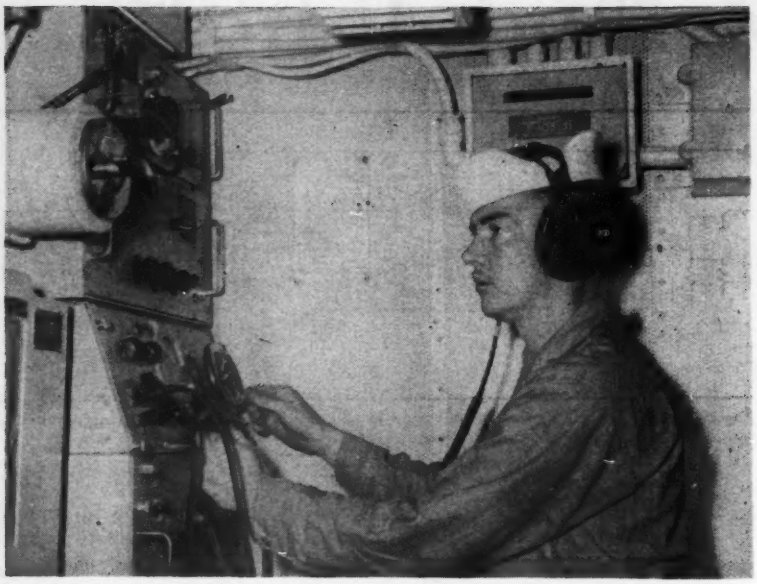


FIG. 3—Overall audio frequency response of transmitter-receiver system

local noise such as that generated by electrical machinery.

Shielding

In noisy locations, it is helpful to use a shielded receiving loop made of small coaxial cable. One end of the inner conductor is connected to the ungrounded receiver antenna terminal, the other end of the inner conductor and the shield braid are connected to the ground terminal. At a point halfway around the loop, the outer braid is cut and stripped for a length of an inch or two. Shielding is effective in reducing electrostatic pickup from nearby noise sources.



Sonar installation on submarine USS Menhaden—Official U. S. Navy photo

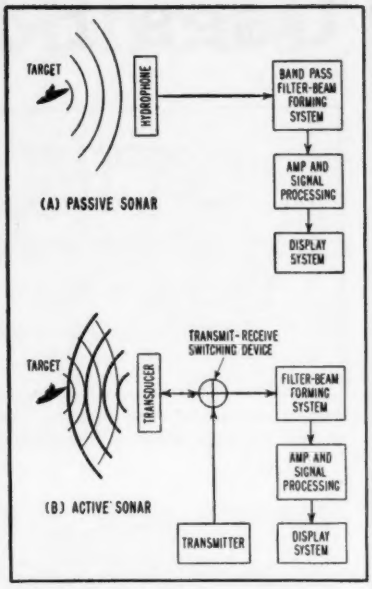


FIG. 1—Basic modern sonar systems

Modern Sonar Systems

SUMMARY —— New transducers and new electronic scanning and searchlighting techniques give increased detection ranges for both active and passive sonar, along with additional data on bearing, course, range-changing rate and type of vessel. Better understanding of sound propagation under water and of natural sea noises permits more effective use of sonar in antisubmarine and prosubmarine warfare as well as in commercial applications

By JAMES A. RUMMELL
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SINCE THE ADVENT of higher-speed nuclear-propelled submarines, sonar has taken on new importance since it is in many cases the only possible means of detecting a submarine. As a result, sonar is extensively used in antisubmarine and prosubmarine warfare. It may also be used to determine the position of the vessel on which it is located by reference to known points, for underwater navigation. The Navy also relies upon sonar for underwater communication to assist in fleet operation. Commercially, sonar finds extensive application in depth determination, fish location and to a lesser extent for bottom mapping.

Sonar Systems

As a result of its increased importance, several new objectives have been established for sonar systems used in military applications. These include longer detection ranges, increased reliability of detection at a given range and the provision of additional bearing, course, range rate and type-of-vessel information about the target.

Two general types of sonar systems are regularly used in military applications. A passive system, shown in Fig. 1A, utilizes a directional hydrophone to pick up acoustic noise radiated from other ships. In the active system of Fig. 1B a burst of acoustic energy is released into the water from the transducer with the expectation of receiving an echo from a nearby ship.

Passive systems are usually confined to use in submarines, since the submarine is capable of operating as an extremely quiet listening plat-

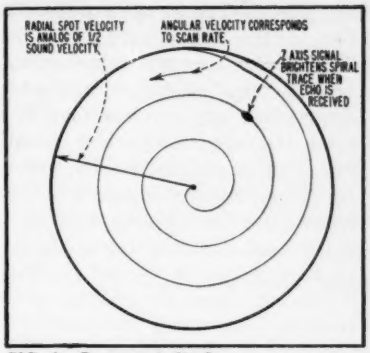

RADIAL SPOT VELOCITY IS ANALOG OF 1/2 SOUND VELOCITY.
ANGULAR VELOCITY CORRESPONDS TO SCAN RATE.
Z AXIS SIGNAL BRIGHTENS SPIRAL TRACE WHEN ECHO IS RECEIVED

FIG. 2—Sonar ppi display

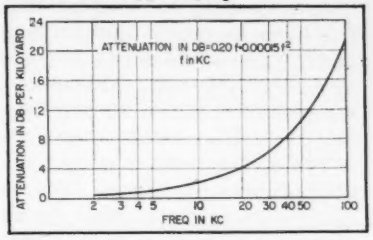
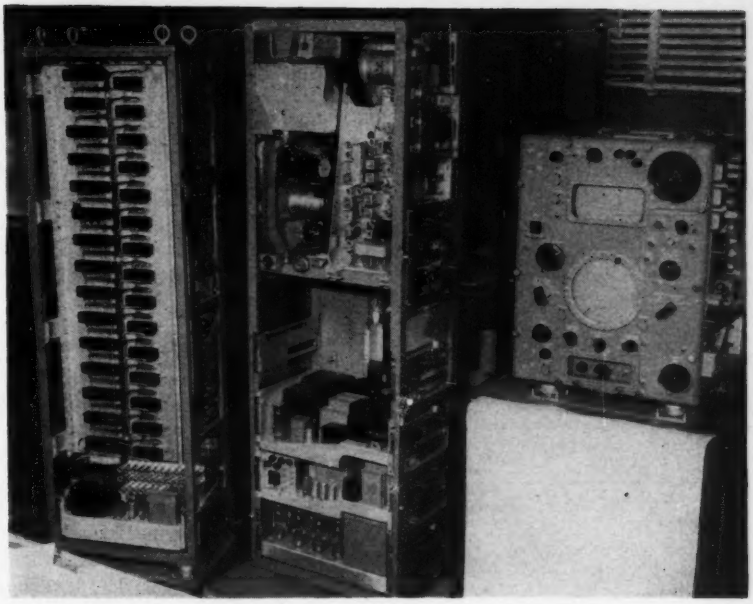


FIG. 3—Acoustic attenuation in sea water



Modern high-speed electronic scanning sonar system partly assembled

Guide Atom Subs

form to prevent masking of weak sounds by self noise. The passive system has the outstanding advantage that it does not reveal the presence of the listener.

Active systems are commonly used on surface ships to radiate high-level pulses of sound at a single frequency, so that echoes are received at a high enough level to overcome self noise.

Display techniques suitable for radar are not directly applicable to sonar because of the relatively low velocity of sound propagation in sea water. Normally this velocity is about 4,800 fps, which requires about 1.25 seconds for sound to make a round trip of 1,000 yards.

In scanning systems, acoustic pulses of from 6 to 36 milliseconds are transmitted omnidirectionally, immediately following which the receiving beam scans in azimuth at rates from 30 to 300 rpm. Since sound range periods are long, the crt trace spirals outward from the center of the ppi screen, as shown in Fig. 2. The receiving beam usually makes hundreds of circular azimuth scans in a single sound range interval, so that the spiral merges into a solid field.

Underwater communication systems utilize all possible techniques to reduce effective bandwidth, such as clipped-speech single-sideband modulating an acoustic carrier. Such equipment permits effective voice communication to ranges of several miles with 100-watt power levels into the water.

Sound Transmission in Water

Water, particularly sea water, is far from being the ideal medium for transmission of any kind of intelligence. Sound is propagated by longitudinal compression of water particles and this compressional vibration results in highly frequency-dependent propagation loss. Figure 3 shows a plot of propagation loss with frequency. Attenuation increases rapidly with increasing frequency.

A more troublesome and much more variable factor that enters into sound propagation in sea water is the existence of velocity gradients which refract or, in some cases, reflect the sound from the desired point-to-point path. Figures 4, 5 and 6 show effects of salinity, depth and temperature on velocity.

Temperature has the most velocity effect over the expected excursion, yet in terms of percentage it is still small. Figure 7 shows the effect of a common thermal condition, designated as a uniform negative temperature gradient. Sound paths are refracted in the direction of lower velocity (temperature), in accordance with laws similar to those that govern optical ray theory. The condition shown in Fig. 7 will prevent sound introduced near the surface from reaching a distant point also near the surface. Temperature gradient variations occur with changes of location, time of day and season, although recent studies indicate that thermal conditions can be predicted more accurately than the weather.

Figure 8 shows the effect of depth (pressure) on sound paths. The paths are deflected away from the higher velocity which occurs at higher pressures encountered at great depths. This effect and that of temperature often contribute to

Multistave cylindrical transducer used to form beam in scanning sonar system

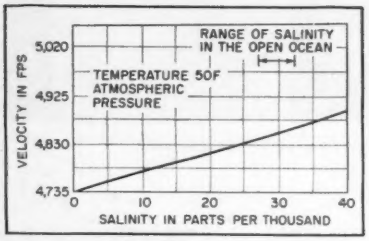


FIG. 4—Effect of salinity on sound velocity

a shadow zone resulting from the pressure-produced upward bending combining with downward thermally caused bending. This shadow zone is shown in Fig. 9. A submarine in either of the shadow zones would probably be undetected.

Deep Sound Channels

The upward bending resulting from pressure and the counteracting downward bending effect resulting from lowered temperature at increasing depths produces an interesting phenomena known as the deep sound channel. Figure 7 shows the sound beam bending downward with decreasing temperature. Velocity also increases with depth since increasing pressures tend to produce upward bending.

In many conditions near the surface the decreasing temperature effect overcomes the opposite pressure effect and therefore the sound beam is bent downward as shown in Fig. 9. At great depths (several thousand feet) the water assumes the temperature of maximum density, 4 deg C. At this point, since there can be no further temperature gradient, the positive pressure gradient effect takes over and deflects the beam upwards where it reenters warmer water. Here it is refracted downward by the negative thermal gradient to form a sound channel, as in Fig. 10.

This deep sound channel exists in almost all deep ocean areas. Sound which enters this channel is transmitted with a minimum of spreading loss so that long ranges can be obtained if this channel can be used. Due to its great depth it is of limited usefulness.

Maximum Range for Sonar

In addition to the above limitations, sound spreads by square-law relationship (except in sound channels) like other forms of radiation, so that, for an echo ranging system, spreading loss is proportional to the fourth power of the distance from the detecting ship to the target. The combined effect of frequency and spreading loss for four frequencies is shown in Fig. 11. For echo ranging systems, the loss for a given range is double that shown. Long-range propagation is thus not to be expected with the higher acoustic frequencies.

For a sonar system to be effective, the sound pressure level produced by the target at the receiving hydrophone must be above the ambient noise in the bandwidth used. The level of sea noise is frequency-dependent and is shown by curves of Fig. 12. Sea noise rises with decreasing frequency at a rate of about 5 db per octave. This increased sea noise often overcomes the advantages of lower transmission frequency. Self noise produced by the sonar carrying vessel generally increases at about the same rate or faster.

Sea animals also contribute to the ambient noise level. Dolphins following near a sonar-equipped ship will often sound like a pack of hounds about to tree a fox, whereas some other animals use sonar systems to locate their prey. Certain types of shrimp produce sounds comparable to that of a large number of chains being banged violently together. Many of these noises are broadband and are intense relative to a weak echo from a distant target ship so they will often mask echoes.

Generally speaking, circuitry used in sonar equipment is similar to that used in other electronic equipment. The greatest difference lies in the hydrophone or transducer which converts sound energy into electrical energy or vice versa. Quartz and adp crystals have been used, but magnetostrictive metals, mainly of the nickel family, are by far the most common material used today. Barium titanate ceramic is being used in increasing quantities because it can be molded in many forms, involves no critical materials, is inexpensive and lighter in weight than nickel alloys.

Both ceramic and magnetostrictive elements require suitable isolation of unused radiating surfaces to achieve efficiency. Transmit or receive efficiencies of 25 to 30 percent are achieved with either.

The nickel element is polarized by a permanent magnet. The ceramic element is polarized by application of high voltage during manufacture, after firing. The ceramic element receives its electrical exciting signal (or delivers an output) from the fired-on silver coating on the inside and outside surfaces.

Arrays

Almost all sonar transducers or hydrophones are made up of a number of elements to provide the beam width and the required directivity. Typical transducers used in scanning systems provide beams 12 to 15 deg wide at −6 db points in both planes. A pattern plotted in a sonar test tank is shown in Fig. 13.

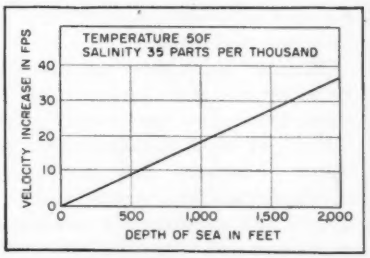


FIG. 5—Effect of depth on sound velocity

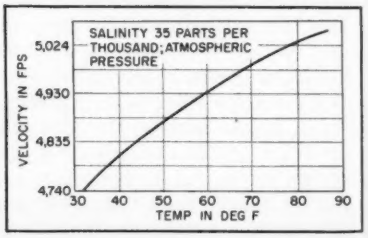


FIG. 6—Effect of temperature on velocity

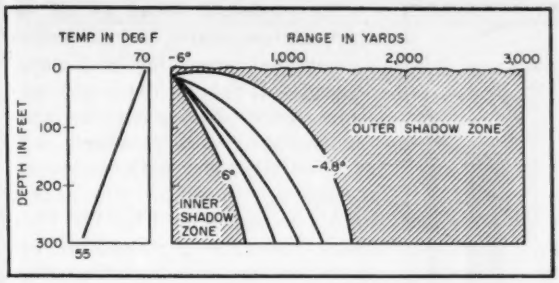


FIG. 7—Sound transmission in uniform negative gradient in water

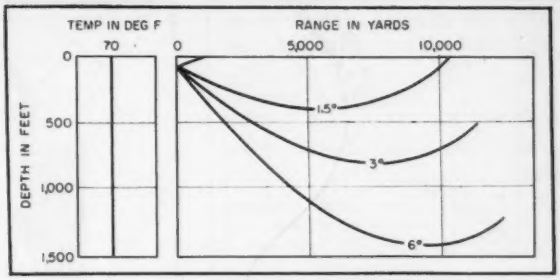


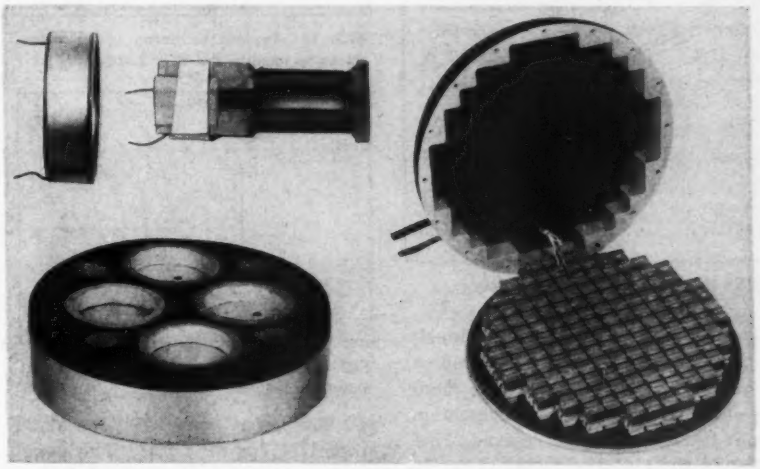
FIG. 8—Sound transmission in uniform-temperature sea water

In many applications, the size of the transducer has limited the lowest frequency at which effective active sonar operation is possible. The pattern shown requires a transducer with an active face about 7.5 inches in diameter at 50 kc. At 10 kc the size will increase to 36 inches and at 2 kc the diameter will be 15 feet. These larger sizes may be entirely unacceptable for mounting on the underside of a ship so are often ruled out for this reason.

Scanning Transducer

The scanning sonar system, which provides essentially omnidirectional azimuth coverage, requires a cylindrical transducer. A typical magnetostriction scanning transducer for submarine installation is shown in section in Fig. 14. If all elements are excited in phase, the beam pattern is essentially omnidirectional in the horizontal plane. The vertical beam pattern is determined by the ratio of height to frequency. Transmitting directivity index for this type of transducer will range from 8 to 12 db.

The receiving beam, which is continuously scanned in the horizontal plane, is formed by using one-third of the total elements to form any one beam. The transducer shown contains 60 vertical rows or staves, with each stave being made up of eight magnetostrictive piston elements. Beam forming is accomplished in this cylindrical-type transducer by use of a beam-forming delay line which delays the electrical signal from the forward elements to produce a composite signal equivalent to a plane array, as in Fig. 15. This basic design represents the most popular shipboard transducer in use today.



Barium titanate and magnetostrictive transducer elements (upper left), typical searchlight transducer using ceramic elements (lower left) and typical searchlight transducer using magnetostrictive elements (right)

Passive systems, which listen for noise produced by the target vessel, are effective in detecting typical surface ships from a quiet submarine platform. Generally, such systems have an adjustable, wide bandwidth, the center frequency of which adjusts over the audio range and slightly above. The hydrophone may be highly directional at the upper end of the band. By careful circuit design the bearing of targets may be accurately determined. Range information is not normally available from this type of gear.

Active systems, usually used on

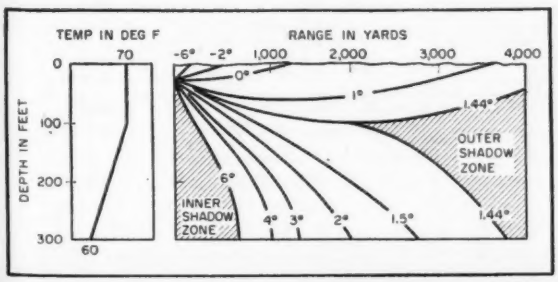


FIG. 9—Sound transmission conditions producing shadow zones

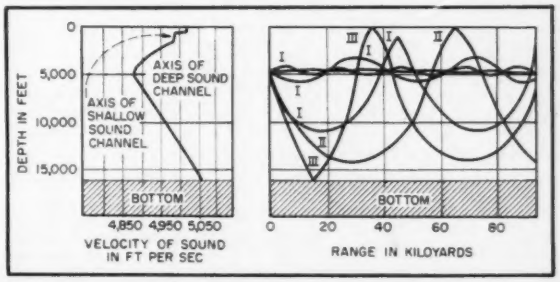

DEPTH IN FEET
AXIS OF DEEP SOUND CHANNEL
AXIS OF SHALLOW SOUND CHANNEL
BOTTOM
VELOCITY OF SOUND IN FT PER SEC
RANGE IN KILOYARDS

FIG. 10—Formation of deep sound channel in ocean

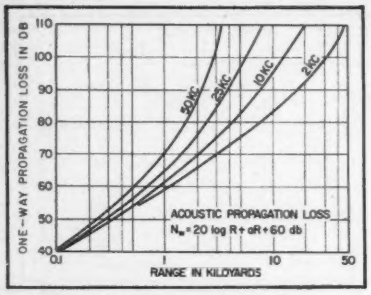


FIG. 11—Acoustic propagation loss

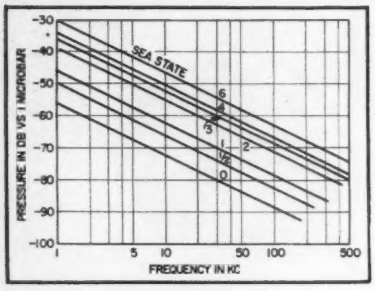


FIG. 12—Sea noise spectrum level

surface ships, are often seriously range-limited by ship's self noise. Therefore, the bandwidth is made as narrow as possible consistent with the echoes to be received. Frequency shift of the reflected transmitted signal resulting from target and own ship's doppler may be significant, since the velocities of ships and submarines is a significant fraction of the velocity of sound. For example, doppler bandwidth for a relative range rate of ±20 knots

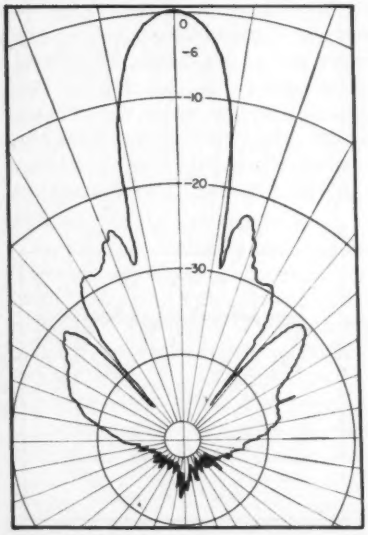


FIG. 13—Typical transducer beam pattern

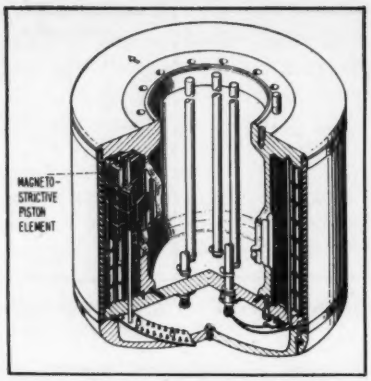


FIG. 14—Typical scanning sonar transducer as used in AN/BQS-2 sonar

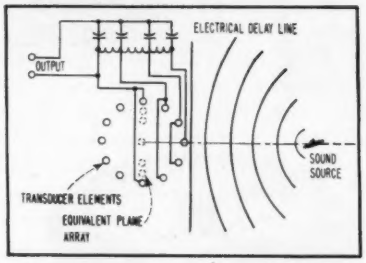


FIG. 15—Beam formation in cylindrical sonar transducer

is 1,400 cps at 50 kc, 700 cps at 25 kc and 70 cps at 2.5 kc. The usual requirements for bandwidth due to pulse length apply but doppler is usually the largest factor and becomes increasingly important as target speeds increase.

Audio presentations, where echoes are usually heterodyned to a zero doppler frequency of about 800 cps, are an essential part of any sonar system because of the unique ability of the human auditory system to identify a frequency-shifted signal in a reverberation background or from noise background. Here ppi displays are used to read range and bearing of the target.

The combined effect of all of these factors, which include propagation loss (spreading and water absorption), doppler-required bandwidth, noise increase with decreasing frequency and transducer loss of directivity index with decreasing frequency (transducer size is held fixed), is shown in Fig. 16. This chart compares performance between two systems operating with the same size transducer at frequencies of f and $2f$.

Other factors being equal, a detection range improvement can be expected by operating at the lower frequency f. This chart does not take into account other factors, such as degradation of bearing resolution, which may occur at the lower frequency. For a given transducer size, there is an optimum frequency of operation for a given maximum detection probability at a given range. This frequency may be calculated using a series of comparisons as represented by Fig. 16.

Typical Sonar Equipments

Electronic design of sonar equipment is straightforward but input circuits present some special problems. Many sonar equipments are capable of threshold operation at an acoustic noise level corresponding to zero sea state, so that at no time in normal operation is the equipment self noise limited. This usually requires operating near the thermal noise level of the input circuit, which necessitates care in selecting tube types and input circuit impedance.

Figure 17 is a simplified block diagram of one type of sonar equipment which displays target bearing as angular displacement from the

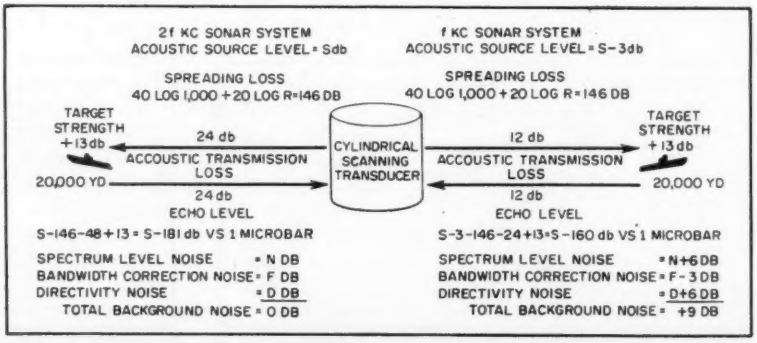

2f KC SONAR SYSTEM
ACOUSTIC SOURCE LEVEL = Sdb
f KC SONAR SYSTEM
ACOUSTIC SOURCE LEVEL = S-3db
SPREADING LOSS
40 LOG 1,000 + 20 LOG R = 146 DB
SPREADING LOSS
40 LOG 1,000 + 20 LOG R = 146 DB
TARGET STRENGTH +13db
24 db
ACCOUSTIC TRANSMISSION LOSS
20,000 YD
24 db
ECHO LEVEL
CYLINDRICAL SCANNING TRANSDUCER
12 db
ACCOUSTIC TRANSMISSION LOSS
12 db
ECHO LEVEL
TARGET STRENGTH +13db
20,000 YD
S-146-48+13 = S-181 db VS 1 MICROBAR
S-3-146-24+13=S-160 db VS 1 MICROBAR
SPECTRUM LEVEL NOISE = N DB
BANDWIDTH CORRECTION NOISE = F DB
DIRECTIVITY NOISE = D DB
TOTAL BACKGROUND NOISE = O DB
SPECTRUM LEVEL NOISE = N+6 DB
BANDWIDTH CORRECTION NOISE = F-3 DB
DIRECTIVITY NOISE = D+6 DB
TOTAL BACKGROUND NOISE = +9 DB

FIG. 16—Comparative sonar performance at frequencies one octave apart

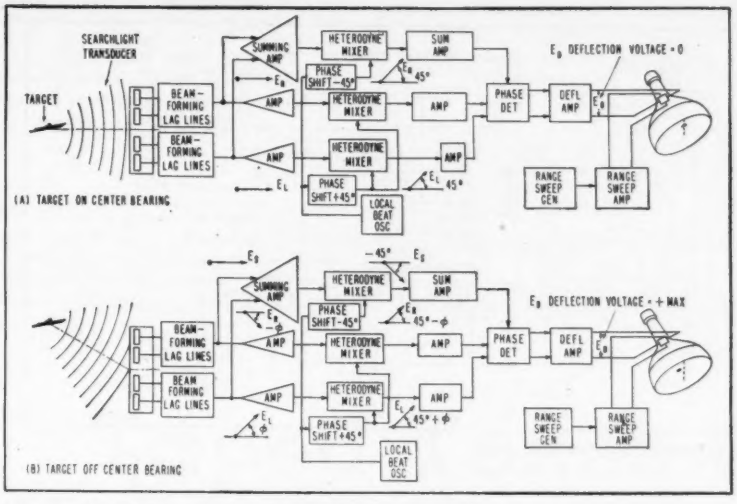


FIG. 17—Phase-comparison bearing-indicator sonar system

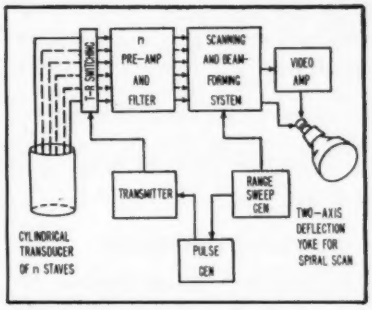


FIG. 18—Typical scanning sonar system

center-bearing line of the transducer. Range is indicated as the distance from the origin of the sweep time base. The input signals are derived from an electrically-split searchlight transducer. The phase difference between the voltages from the two halves varies from zero degrees when the target is on center bearing to 180 degrees when the target is on the bearing of the first null of the transducer. This type of display offers the advantage of high bearing resolution without requiring a large transducer to produce a narrow beam.

Scanning Sonar

Figure 18 is a simplified block diagram of a typical scanning sonar which is most commonly used in general-purpose military applications. A cylindrical transducer is used. During transmission, t-r relays connect all the transducer staves together and to the transmitter output. The transmitter is keyed on for pulse lengths from 6 to 80 milliseconds. The resultant transmission pattern is omnidirectional in azimuth.

At the end of transmission the transmitter is disconnected from the staves and received echo signals are applied to separate stave preamplifiers which raise the received signal well above thermal noise level. To provide uniform scanned receive beam coverage, 48 vertical staves are used in the example illustrated.

The output of each of the 48 preamplifiers feeds one of the insulated sector-shaped capacitor plates which is part of the stator of a rotating capacitor. These fixed plates are represented by the outer circle of 48 plates shown in Fig. 19. There are also 48 sectors on the rotor which are continuously scanned in close proximity to the stator plates at 30 rpm in the system represented.

Sixteen adjacent rotor plates are used to feed taps on the beam-forming delay line which is part of the rotating assembly. The remaining 32 rotor plates are grounded. Therefore, at the slip ring brush, a voltage appears which corresponds to a scanned receive beam which covers the entire azimuth plane 30 times a second.

Following the scanner output, further amplification and filtering is applied. In accordance with information theory, the scanning process increases the required bandwidth. After conversion to an i-f

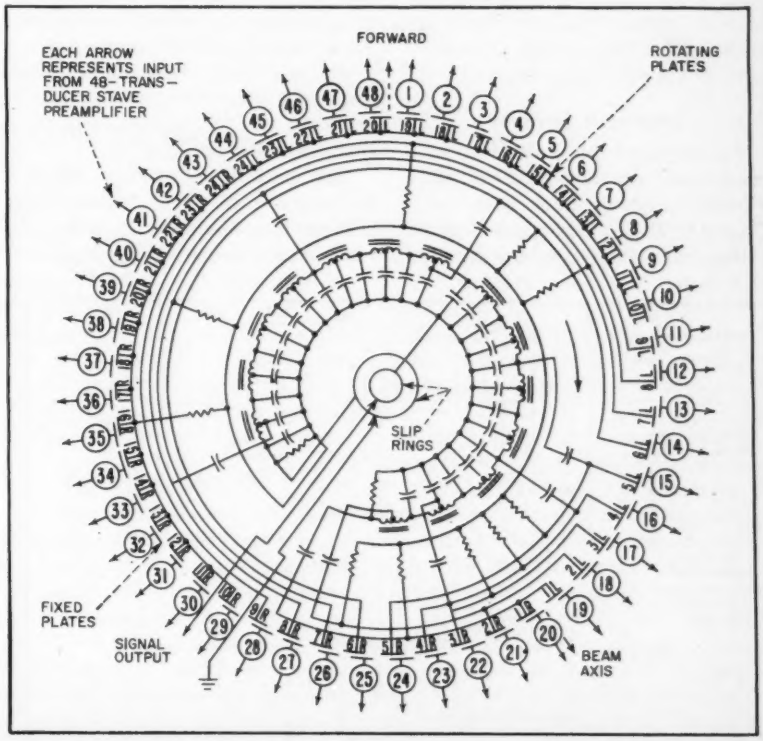


FIG. 19—Circuit of transducer scanner showing capacitive coupling technique

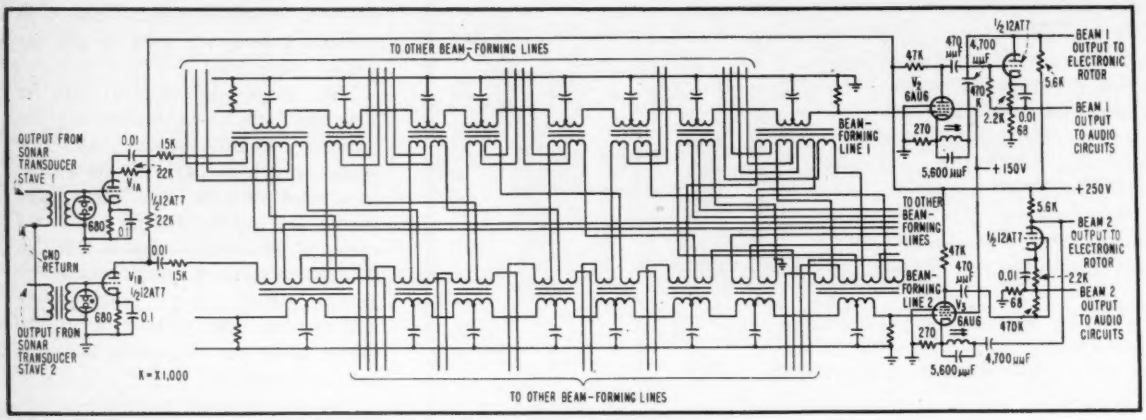


FIG. 20—Transducer stave preamplifier arrangement feeding beam-forming line

value the signal is amplified by several stages, detected to form a video signal and applied to the intensity-modulating grid of the ppi cathode-ray tube.

Circular sweep is provided from a three-phase generator driven from the mechanical scanner. The d-c field of the generator receives a slowly-rising d-c voltage corresponding to a linear time base sweep. The spot then describes a tight spiral which makes one revolution per scan and gradually increases in diameter corresponding to sound range. This provides a ppi display which is similar in appearance to the ppi radar display.

Electronic Scanner

To overcome the limitations of a mechanical scanner, several other effective systems have been used. The AN/BQS-2 submarine sonar utilizes a 60-stave cylindrical transducer. Transmission is accomplished as in the preceding system. Twenty of the staves are used to form a single receiving beam. A preamplifier for each stave is used, but each output feeds 20 of a total of 60 beam-forming delay lines so that 60 preformed beams result. These 60 beams are continuously in existence, as opposed to the mechanical scanner system in which only one beam is formed as the azimuth plane is scanned.

Two typical preamplifiers, V_{1A} and V_{1B}, are shown feeding parts of a beam-forming line in Fig. 20. Each beam-forming line is fed by a total of 20 such preamplifiers. The composite beam output is obtained from the end of each line and further amplified by V_2 or V_3.

The outputs of the 60 beam-forming lines are successively scanned by a diode rotor which consists of 60 diodes, which all have their cathodes tied together and to an amplifier. Such a diode rotor is shown in Fig. 21. The plates of the 30 6AL5 tubes connect to their respective beam outputs and to a pulse signal tap on the beam-switching delay line. This line is electrically the length of one scan or one revolution, which in this case is 3,333 microseconds for 300 scans per second.

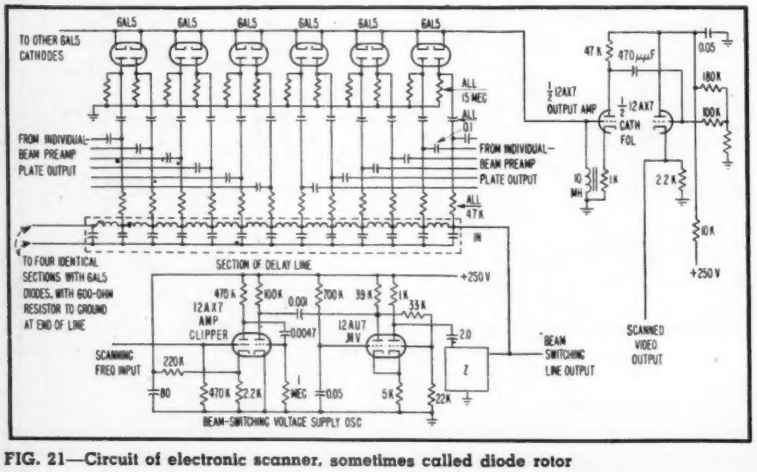

TO OTHER 6AL5 CATHODES
FROM INDIVIDUAL BEAM PREAMP PLATE OUTPUT
TO FOUR IDENTICAL SECTIONS WITH 6AL5 DIODES, WITH 600-OHM RESISTOR TO GROUND AT END OF LINE
SECTION OF DELAY LINE
12AX7 AMP CLIPPER
12AU7
SCANNING FREQ INPUT
BEAM-SWITCHING VOLTAGE SUPPLY OSC
BEAM SWITCHING LINE OUTPUT
SCANNED VIDEO OUTPUT
½12AX7 OUTPUT AMP
½12AX7 CATH FOL
+250V

FIG. 21—Circuit of electronic scanner, sometimes called diode rotor

Delay Line Output

The five-part delay line has 59 taps to provide a total of 60 output points, at each of which a voltage pulse appears serially and delayed from the preceding one by 1/60th of a scan revolution. Each of 60 beams is thus switched on for about 1/60th revolution, once per revolution or 300 times per second. Thus, scanning is serially accomplished of each of the 60 preformed beams. The triode output amplifier (½12AX7) following the scanning function increases the signal level, after which it is applied through a triode detector to the video system to provide trace brightening of target echoes.

Circular sweep voltage is obtained from the beam-switching delay line. The switching voltage is filtered to remove harmonics that were required to form the correct switching pulse wave shape, before being used to provide scan voltage for the cathode-ray indicator.

Acknowledgement is extended to D. M. Sherwood and W. S. Leitch of Bendix Pacific for their help and encouragement in gathering material for this article.

FIG. 1—Control system for overhead crane operation consists of a tape recorder, frequency generator and frequency-selector panels and a control panel to provide automatic operation

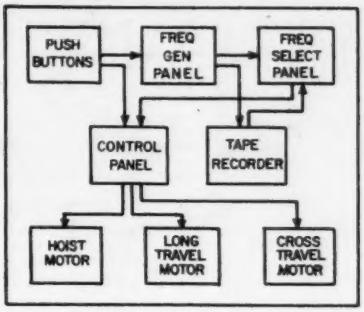
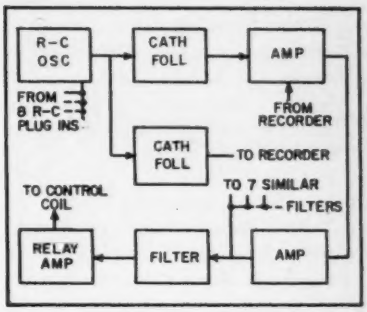


FIG. 2—Eight preset frequencies in frequency generator are fed to the recorder for preparation of automatic operation or directly to frequency-selector for manual operation of overhead crane



Taped Tones Control Overhead Crane

SUMMARY —— Eight preset frequencies or tones activate selector relays which operate crane motor contactor equipment. Sequence of preselected operations recorded on magnetic tape is repeated by traveling crane during playback. For complicated sequence of movements tapes can be prepared by computer. Positioning accuracies of better than $\frac{1}{8}$ in. can be maintained over many hours of automatic or manual operation in any sequence

By G. V. SADLER Vaughan Crane Co., Ltd., Manchester, England

AUTOMATION and high labor costs have encouraged the development of automatic control gear for overhead traveling cranes engaged in repetitive duties. In the storage and removal of bulk materials; coal, ash and phosphates; the handling of pulp for paper making and the transfer of semifinished materials into and out of machine tools for processing, the crane operator frequently works on a cycle of operations which is repeated periodically for equal-capacity loads.

This article describes a new control system using frequency control of selector relays which operate the crane drive-motor contactors.

A stockyard containing drums of chemicals is serviced by an overhead crane, whose function is to load drums on railroad cars or a conveyor. Drums stored in various positions in the yard and containing the same material must be loaded periodically. Lifting tongs make a load slinger unnecessary. Six crane motions involved are up, down, traverse-to, traverse-from, travel-to and travel-from.

Operating Sequence

The six-pushbutton control panel, located on ground level adjacent to the crane gantry structure, permits a sequence of preselected operations to be recorded on magnetic tape. During playback of the tape the sequence of movements is repeated by the crane as often as required. Different recordings are made to handle different drums.

Control equipment shown in the block diagram of Fig. 1 consists of a frequency generator panel, a remote-control panel, a frequency-selector panel and a tape recorder. A block diagram of the frequency-generator and selector units is shown in Fig. 2.

Eight preset frequencies or tones are available for single selection from the frequency generator through control-box pushbuttons. A selected cycle of motions is obtained by which frequencies are chosen by the frequency selector to operate the relays and crane contactors. Oscillator circuit values are given in Table I. The operation sequence tones are recorded on tape. With playback to the selector, the crane initiates the origi-

nal set of functions as recorded.

The process can be repeated as often as desired. Using only two connecting leads, the frequency selector combination allows remote control of a number of relays or contactors.

Frequency Generator

The circuits for the frequency generator and the frequency selector units are shown in Fig. 3. It is necessary to change over the recorder leads *X* and *Y* and open switch *Z* when transferring from recording to playback.

Preset frequencies are generated in the frequency generator by an R-C phase-shift oscillator. A frequency-preset potentiometer allows precise adjustment of the oscillator to a standard frequency and the amplitude preset potentiometer varies the output sine wave.

Duplicate small plug-in circuits provide eight preset frequencies. The output of the oscillators are combined in the grid circuits of the cathode follower stages for separate matching to the frequency selector and tape recorder. Individual output amplitude controls are available.

Frequency Selector

The grid circuit of each of the eight filter relay amplifiers comprising the frequency selector has a high-Q L-C network resonant to one generator or recorder input tone. The resonant voltage is rectified and applied in opposite polarity to the negative voltage selected by the relay trip preset potentiometer. One of the tubes conducts and the relay connected in the plate circuit is energized. Indicator lamps register the operation of relays and special circuits and provide a regulated +150-v and −105-v d-c supply with reference to chassis.

Although only six tone sources are needed for crane operation two or more sources may readily be added to accommodate lifting magnets or other equipment. One tone source energizes and the other deenergizes the magnet. If an auxiliary hoist motion is needed, two additional tone sources may be provided.

Table I—Values of R-C Network for Each of Eight Frequencies

Chassis No	Frequency in cps	C_1	C_2	C_3	R_1	R_2	R_3	R_4
		in μμf			×1,000 ohms			
1	270	460	460	390	135	270	560	1,000
2	1,600	220	220	100	135	100	270	270
3	450	390	303	270	195	560	560	1,000
4	2,600	127	100	68	135	100	270	270
5	700	460	290	330	135	270	270	270
6	3,800	68	68	78	100	100	270	270
7	1,080	330	270	270	100	270	270	270
8	4,500	100	68	25	100	47	270	270

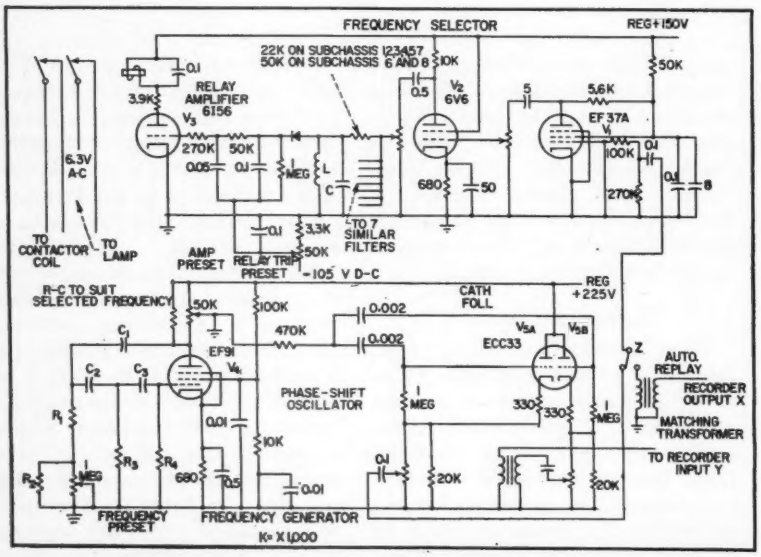


FIG. 3—Variation of R-C networks in the grid circuit of phase-shift oscillator in frequency generator provides eight tones hence eight crane movements

An operating control panel for a three-motion crane fitted with a lifting magnet is illustrated in Fig. 4. At the top of the panel are 16 pushbuttons. Eight provide the initial manual setting of a series of crane motions. The remaining eight directly connect to the crane contactor gear, mounted at the bottom of the panel, to assure direct manual operation of the crane if required. These buttons may also be used for discrepancy correction during an automatic set of operations.

Tape Speeds and Lengths

Tape choice depends on the crane duty cycle and working conditions. A process cycle for industrial handling can often be accommodated within a 20-minute period.

An industrial recorder, with tape speed of $3\frac{3}{4}$ ips provides a one-hour record and requires rereeling. Alternately, a continuous tape may be used which repeats a 20-minute program as often as desired.

Signal reproduction was found to be satisfactory at $3\frac{3}{4}$ ips except at tone frequencies above 4 kc where a speed of 7 ips is more reliable. Since all tone sources used are audible, the quality of the reproduction may be monitored on a loudspeaker. Signal strength can similarly be checked during recording by adjusting the gain control.

Accuracy and Feedback

A crane, fitted with a lifting magnet and controlled by the methods described, has satisfactory positional accuracy over long periods with signals on a time base only. Under automatic control a program must be started and finished with the crane hook in the same position relative to the crane and its gantry track. This is done by insuring that the last manual move of a preset program causes crane and hook to stop by their own limit switches at the top of hook travel and at the end of bridge travel.

After a crane is broken in, gears and bearings have lost their initial stiffness and brake linings are well bedded, accuracies down to $\frac{1}{8}$ in., satisfactory for many crane duty cycles, can be maintained on all motions for many operating hours.

Since frictional resistance varies

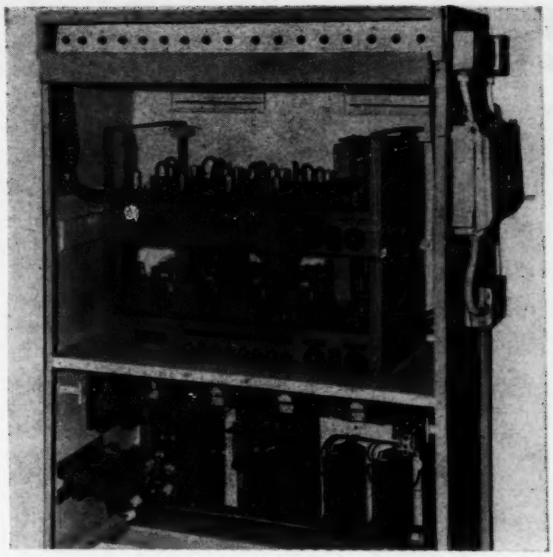


FIG. 4—Operating control panel for three-motion crane with lifting magnet has 16 pushbuttons at top of unit

Operator adjusts recorder for playback of automatic sequence. Control panel bushbuttons allow manual intervention

with ambient temperature, the wear on brake linings increases at the point at which a crane hook comes to rest after the brake is deenergized. On the hoist motion of a crane a synchro, operated by a light steel wire attached to the crane hook through gearing, is added. Inaccuracies resulting from load rope stretch which would be evident if the synchro were driven directly off the crane rope barrel are overcome. Correcting signals for positioning are then superimposed on the recorded program for the hoist motion by feedback.

Traverse and Travel

Although a synchro drive may be used for traverse and travel motions, another method uses a strained wire of resistance material stretched along the crane track. The wire passes through a ground point on the crane and forms one leg of a bridge circuit used for impulse correction relative to position.

This system is particularly suitable for cranes provided with eddy-current coupling drives in balance. Smooth deceleration feature of this drive greatly increases the stability of the system and eliminates a tendency to hunt.

Controlled acceleration and deceleration are advantages for accurate positioning.

Magnetic tape is not the only method of initiating control signals to the frequency selector equipment. In fact, when feedback circuits are added, the initial programming by manual control can be eliminated. A simple set of crane movements can be designed to meet a particular need and coded for reproduction on punched tape. The tape is used as the signal transmitter to the frequency selector panel.

A more complicated sequence of crane movements including such variables as different types and weights of loads, times and speeds can be analyzed and fed into a computer. The integrated record is then produced on magnetic or punched tape and fed into the frequency selector circuit thereby extending automatic crane uses.

Two Wire Control

The frequency control system is easily adaptable to the operation of remote controlled cranes without including the automatic equipment. Remote manual control from a fixed position at ground level normally needs a large number of conductors carrying motor and switch circuits to the machine concerned.

Where great lengths make use of flexible suspended cables impractical, circuits must be transferred through bare conductor wires or bars to the crane itself. A normal three-motion crane needs 24 such conductors including the limit-switch circuits.

By using frequency control between control point and crane the number of conductors is reduced to the two d-c or three a-c power feeds to the crane, plus two frequency-control wires. Frequency selector relays are mounted on the crane. If site conditions are suitable, a grounded return can be used in place of one of the control wires.

The Chess Crane

As a demonstration of automatic control, a three-motion overhead traveling crane fitted with a lifting magnet played a game of chess.

A large full-scale chess board was placed under the crane and a set of chess pieces, each topped by a suitably shaped steel disk or bar, was provided. Heaviest of the timber pieces was a 15-lb king; the 3-lb pawn was lightest. The steel pole pieces drop off infallibly when the magnet is deenergized.

A full game occupied 30 min and allowed white to win in 29 moves. Every move was manually prerecorded on the tape and the crane was operated by pushbutton controls. The pushbuttons operate the crane through the tuned relay circuits, and all signals were simultaneously tape recorded.

Transistor Reflex Circuit

SUMMARY —— Four transistors in portable radio do the work of five as second i-f stage doubles as audio amplifier. Direct-coupling an *npn* reflex stage to a *pnp* output amplifier effects further savings with elimination of one transistor, five resistors and one electrolytic capacitor. Four flashlight dry cells supply all power.

By **ERICH GOTTLIEB** Application Engineer, General Electric Company, Syracuse, New York

THROUGH REFLEX circuitry a 6-v 4-transistor radio can duplicate at lower cost the performance of a 5-transistor radio having a 200-μv/m sensitivity and a power output of 50 mw at 10 percent distortion. The radio uses standard transistors and has no more playthrough and distortion than the average receiver.

Electron-tube reflex radios were fairly common in the United States and Australia in the pre-World War II era and are still in commercial use in Australia. These receivers suffer from serious distortion and high playthrough, although the advent of remote-cutoff tubes and the use of low a-f plate load resistors have provided a considerable improvement. Now the development of transistors has reawakened the industry's interest in such a receiver since there is no longer a filament feedthrough problem, and the saving of one transistor is still incentive enough to warrant a closer look.

Characteristics

The diagram of one such receiver is shown in Fig. 1. The output stage is a single-ended class-A circuit operating at 23 ma collector current with a collector-to-base voltage of about 4.5 v. The d-c dissipation is about 100 mw. Using a commercial output transformer this circuit will give 50 mw maximum power output at 10 percent distortion and 40 mw with less than 5 percent distortion. The bias and temperature stability is adequate to permit the 2N241A to perform acceptably up to 55 C ambient temperature without danger of damaging the transistor.

The driver is part of the reflex system, but it can be treated separately since there is little interaction between audio and i-f loads. Transistors are essentially independent of collector voltage within the 3 to 12-v range and a relatively large collector resistor therefore affects i-f gain little from a d-c standpoint. This audio load must be bypassed for i-f signals. The i-f load is essentially a short circuit at audio frequencies, thus permitting the use of a split input and output load.

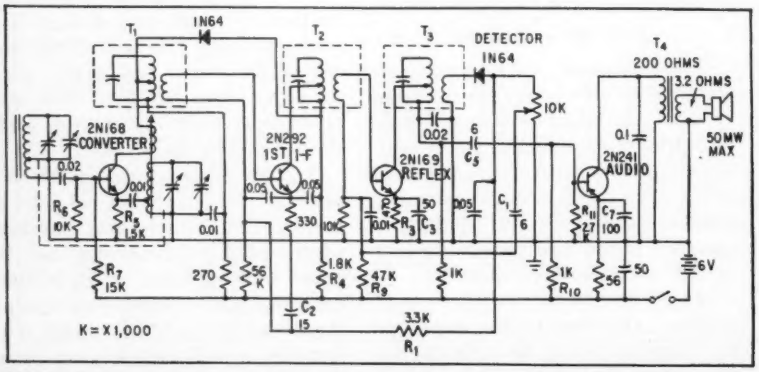


FIG. 1—Schematic of four-transistor reflex portable radio using six-volt supply

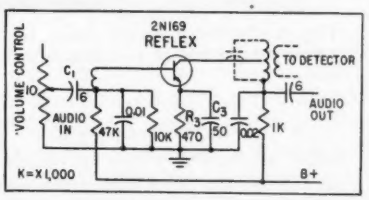


FIG. 2—Audio function of reflex circuit

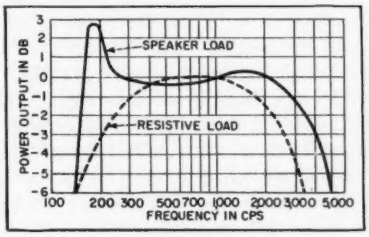


FIG. 3—Overall audio response curve

The audio signal is taken off at the volume control by C_1 and applied at the base of the 2N169 which is used as a combination audio driver and second i-f amplifier. The audio function alone is detailed in Fig. 2. The additional gain of this reflex circuit over a conventional circuit is basically the audio power gain of the R-C coupled amplifier, which is approximately: $P_o = h_{fe}\ (R_L/h_{ib})$.

Trims Receiver Costs

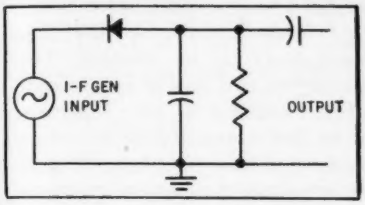


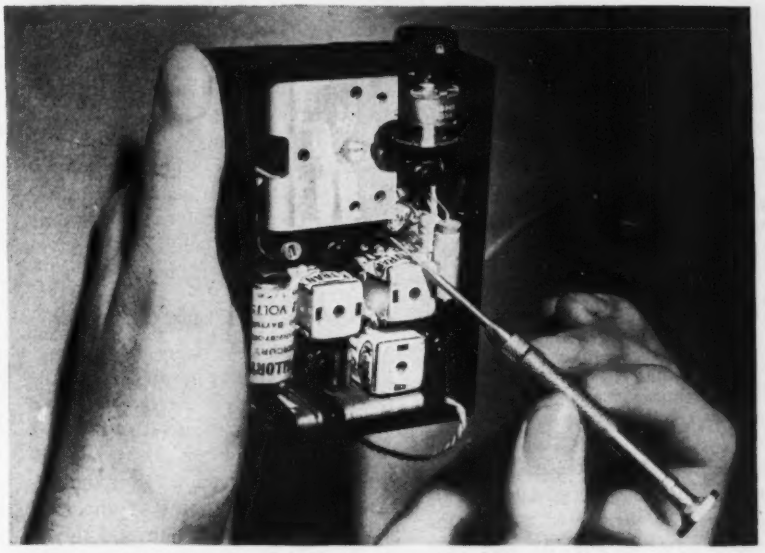
FIG. 4—Equivalent circuit of detector

Since both R_L and h_{ib} are somewhat fixed by i-f overload considerations the best gain can be obtained with high h_{fe}, which is 50-200 in the 2N169. This transistor also has a narrow h_{fe} spread.[1] The audio sensitivity at the volume control is essentially the same as in a 5-transistor R-C coupled radio. Overall audio response is shown graphically in Fig. 3.

Detector and Second I-F

In the detector stage a slightly forward-biased diode operates out of the square-law detection portion of the I-E characteristics. This stage is also used as source of agc potential, derived from the filtered portion of the signal as seen across the volume-control detector load. This potential is proportional to the signal level and is applied through agc filter network R_1 and C_2 to the base of the first i-f transistor so as to decrease collector current at increasing signal levels. The operating point of the first i-f stage is chosen at 0.6 ma to obtain almost optimum gain at a point where it takes little power to get maximum avc action.

The second i-f stage is conventional, with the operating point at 1 ma collector current. This represents about maximum gain for relatively small supply current. Two important changes, however, stem from its use as a reflex stage. The first is the large emitter bypass capacitor C_3. This bypasses R_3 in the emitter both for i-f and audio and must therefore have low impedance at both frequencies. Second and more important is the choice of i-f transformer. With a supply voltage of 6 v, an operating point of 1 ma and a total emitter and collector load resistance of 1,500 ohms, the remaining collector-to-base voltage is only 4.5 v. At high signal levels the peak-to-peak a-c swing may approach this value and the resulting clipping causes distortion and regeneration.



Compact superheterodyne receiver made by Westbury Electronics uses four transistor reflex circuit to get five transistor performance

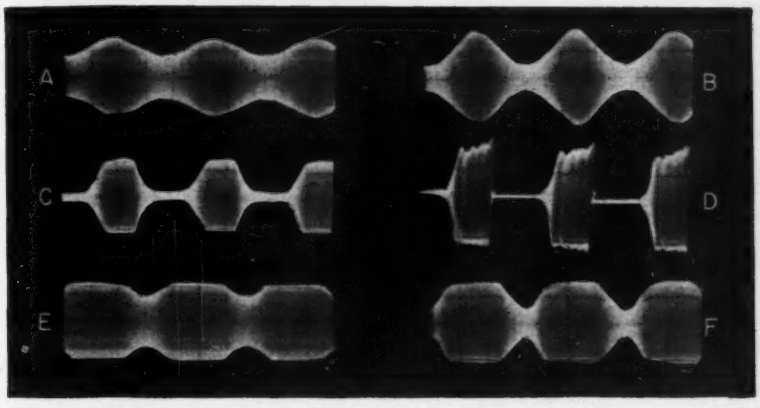


FIG. 5—Detector waveforms at various levels of signal and modulation. No distortion occurs at medium signals with 30-percent modulation (A) and 60-percent modulation (B). Other patterns show clipping or regeneration

Overload Considerations

Playthrough, minimum volume effect and overload have a common cause in a transistor reflex set. The peak-to-peak signal in the collector will tend to exceed the applied d-c potential, causing clipping in high signal level stages when operating at low supply voltages. The equivalent classical detector circuit is shown in Fig. 4. The diode (base-to-collector) is back-biased appreciably and thus will operate only at high signals. When it does, the modulation envelope is affected in the following sequence. When clipping first occurs there is a squaring of the envelope accompanied by an apparent increase in percentage of modulation as shown in Fig. 5C. In a reflex set regeneration occurs next as seen in Fig. 5D. As input is further increased

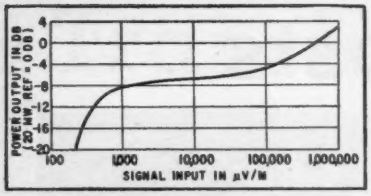


FIG. 6—Severe bend in avc characteristic is necessary to avoid signal clipping

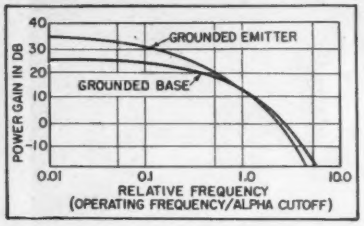


FIG. 7—Grounded-emitter configuration offers greater gain in broadcast band

the modulation is affected in a compression-like manner giving the appearance of a decreased modulation percentage as in Fig. 5E and 5F.

As the input signal is increased still further the envelope is compressed nearly to the point of complete elimination of the modulation. As a result of such severe overloading little or no audio at all is seen at the detector. This condition is not a result of reflexing but can be found in any transistorized radio without auxiliary or multiple stage avc. In reflex circuits, however, another problem arises from this clipping.

Referring again to Fig. 4, the clipped and thereby detected signal appears across the same a-f load resistor as the normal feedback signal. Since both are in phase, regeneration occurs at high signal strength as in Fig. 5D.

The limiting factors in terms of clipping are the supply voltage and the i-f load impedance. If the latter were low, more power would be received at the output stage before i-f clipping, thus delaying this clipping to a larger signal input.

Desirable design criteria in this radio thus require that no i-f clipping occur before the audio stage obtains enough drive to produce maximum output. At that moment the avc should take over radically and keep the signal from becoming large enough to cause clipping in the output i-f transformer. Thus high audio system gain, a supply voltage as high as possible, a low-impedance i-f transformer and an excellent avc system are the ingredients of the successful application of reflex circuits to transistor radios.

The audio gain in this radio is the gain of the reflex driver plus the gain of the class-A output stage. It is quite adequate and about 60 db. The supply voltage is fixed at 6 v, the reflected impedance of the i-f transformer is only about 3,600 ohms and auxiliary avc gives adequate performance.

First I-F, AVC and Converter

The first i-f stage is conventional. In the operation of the auxiliary avc a diode is connected to the primary tap of the first i-f transformer, where the d-c potential is fixed at 5.75 v by the stable operating point of the converter transistor. When tied to the d-c load of the first i-f stage at the top of R_4, this diode has about 0.75-v reverse bias and will thus appear as a high impedance. As the signal level at the detector creates an agc potential the collector current of the first i-f stage drops and the voltage at R_4 rises. At high signal level this d-c voltage approaches 6 v, thus forward-biasing the diode. The resulting low impedance shunts T_1 and thereby reduces the gain at this point. The avc characteristic is shown in Fig. 6.

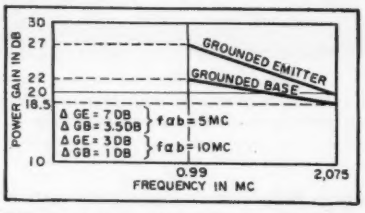


FIG. 8—Lesser slope of grounded-base power-gain characteristic assures better linearity over operating frequency range

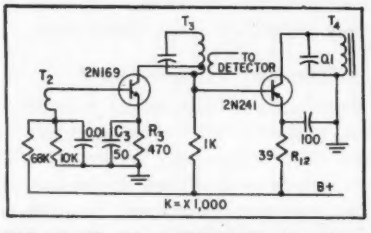


FIG. 9—Circuit modifications for direct coupling of output audio amplifier

In the converter stage the mixer operates in the grounded-emitter configuration for optimum gain. The oscillator operates in the grounded-base configuration since more linear gain over the frequency band can be obtained. The reasons for this choice can be seen in Fig. 7 and Fig. 8. Gain superiority of the common-emitter (over the common-base) configuration in the broadcast frequency range is apparent. The common-base configuration has a lesser slope, however, and will give more linear gain over the band.

The bias stability factor is expressed as $(1/R_5)/(1/R_6 + 1/R_7)$ and in this case is 4. This permits the replacement of the converter transistor without great variation of operating point. The oscillator will function down to one-half the supply voltage without appreciable frequency shift.

Direct Coupling

The advantages of the reflex radio are savings in size and cost since three resistors and one transistor have been eliminated. Further economies can be effected by the use of an *npn* transistor driving a *pnp* unit, which lends itself well to the application of direct coupling. As shown in Fig. 9, C_5, R_{10} and R_{11} have been completely eliminated and the base bias voltage of the output transistor derived from the drop across R_9. This voltage is fixed since the relatively good stability figure of the driver stage fixes the collector current. By lowering R_{12} and changing the stability figure of the driver stage, varying degrees of stability can be obtained for the output circuit.

Using this circuit the radiated sensitivity at 24 in. is increased to 120 μv/m at 1,000 kc. This improvement results from the removal of the initial coupling and bias circuit which introduced a 1-db loss.

In addition to reducing the set drain by the 1 to 2 ma formerly required by the bias circuit of the output stage, the set size and cost is additionally reduced by one electrolytic capacitor and two resistors.

REFERENCE

(1) T. P. Sylvan, Conversion Formulas For Hybrid Parameters, ELECTRONICS, p 188, Apr. 1, 1957.

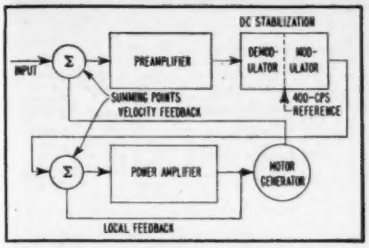
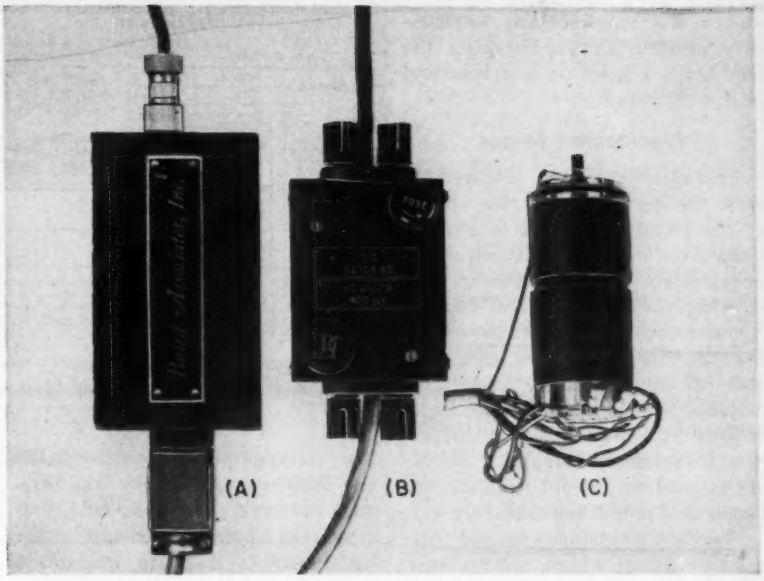


FIG. 1—Servo system employs velocity feedback overall as well as negative feedback locally in power amplifier



Three units of system comprise servo amplifier (A), output transformer (B) and motor-generator (C). Amplifier occupies 17 cu. in.

Semiconductors Shrink Servo System Size

By **HERBERT L. ARONSON,** *Project Engineer*
WILLIAM R. LAMB, *Electronics Engineer*
Baird Associates—Atomic Instrument Co. Cambridge, Mass.

SUMMARY —— Velocity-type servo system uses single-rate feedback loop and d-c stabilization. Network design is based on constant-current driving source and low-impedance load conditions imposed by transistor operation. Double common-collector power stage with inverse feedback lowers output impedance by factor of 200 and cuts motor corner frequency in half. Power resistors mounted on copper-bar heat sink minimize stabilization needs

DEMAND for a miniature servo system of lower power consumption has resulted in the development of a unit having the advantages of transistorized design, greater life expectancy, smaller size, simpler thermal design and lower operating voltages.

The servo amplifier and associated motor-tachometer form a highly stable and accurate rate servo system, the operation of which is insensitive to carrier frequency variations. The desired 5-cps bandwidth is achieved by d-c stabilization specifically designed for operation at transistor impedances.

Power Levels

Maximum power output of six watts is developed from a 15-mv input signal. Overall power gain is thus 98 db. A maximum of 400 ma is required from the 28-v supply to maintain this power level only for brief moments of rapid motor acceleration. Full-speed motor operation at 4,000 rpm causes a 200-ma current drain. Under standby conditions the drain falls to 28 ma.

The block diagram of Fig. 1 shows the fundamental system. An a-c preamplifier supplies driving power for a phase-sensitive demodulator. The resulting low-frequency error signal passes through the stabilization network to a phase modulator. Efficiency of the stabilization and conversion circuitry

makes d-c amplification unnecessary. Power stages following the modulator consist of a driver and push-pull output.

Preamplifier Stages

Preamplification is required to raise the signal level at the output of the summing circuit to a value suitable for demodulation. Approximately 90 db of power gain is achieved with three R-C coupled common-emitter stages shown in Fig. 2. The high-impedance output of the summing circuit is matched to the low-impedance input of the first transistor by a subminiature transformer. Magnetic shielding is used to prevent coupling between this and other transformers.

The first two stages employ silicon transistors which, due to their low leakage currents, require no emitter stabilization over the desired operating temperature range. A germanium transistor is used in the output stage to supply up to 60 mw drive to the demodulator. Loop gain of the system is controlled by changing the value of R_1 and thereby varying the amount of current feedback in this stage. Some feedback must be retained to ensure proper operation of the d-c stabilization circuitry since it is designed on the basis of a constant-current driving circuit of high output impedance.

Phase-sensitive demodulation of the preamplifier output supplies the input signal for the stabilization network. Network output is converted to suppressed-carrier a-c by means of a phase modulator. Both demodulator and modulator consist of full-wave switching circuits utilizing subminiature silicon diodes. The circuit has a 50-db dynamic range characterized by extremely low drift and residual output.

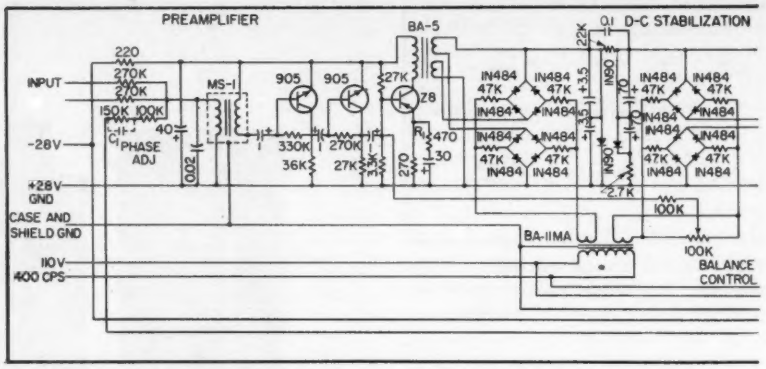


FIG. 2—Schematic of servo amplifier system. Value of C_1 is chosen to correct tacho

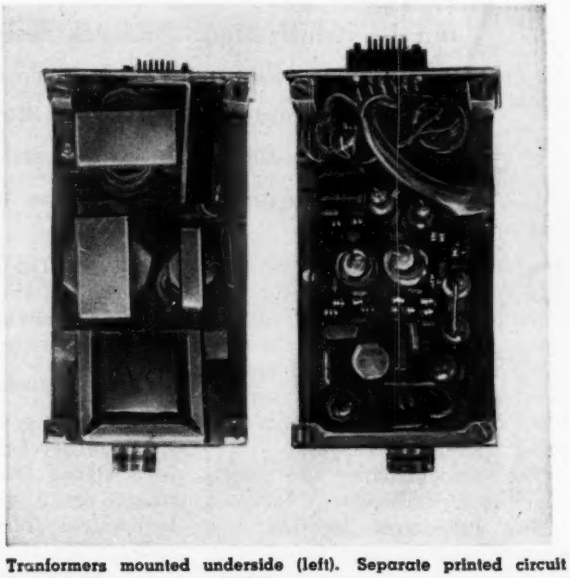
Impedance Functions

Because of the switch-type nature of the circuit, both the modulator and demodulator appear as impedances which are functions of their driving and load impedances respectively. Thus the demodulator acts as a current source for the stabilization network while the modulator is made to appear as a low-impedance load for the stabilization network.

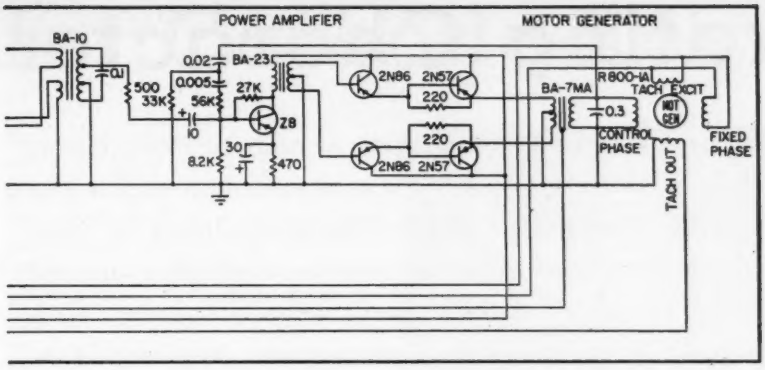
Conventional designs are developed on a voltage-transfer basis which assumes a constant voltage source and an infinite-impedance load. Neither of these assumptions is true in the system under discussion. A power loss of 50 db could be anticipated if the output of such a network were loaded by the input impedance of a transistor. But if current is taken as the dependent variable the design will be based on a constant-current driving source and a low-impedance load. Reasonable impedance matching is then possible and the only power loss is that due to any series resistance in the network itself.

An R-C network designed on a

Epoxy glass circuit board (top) measures 1¾ x 3½ in. Two-board assembly shown in side view (below)



Tranformers mounted underside (left). Separate printed circuit board holds other parts (right)



meter phase shift. Value of R_1 controls current feedback and loop gain

current basis allows for a realistic value of output termination. An L-C circuit would require 5,000 henrys to obtain the desired characteristics, and while such a choke is obtainable in miniature size the high series resistance would negate the advantages. The R-C circuit is therefore used because of its simplicity, reasonably small components and moderate efficiency.

The network is designed on the basis of a 10,000-ohm termination; the value presented by the input impedance of the modulator when loaded by the first power-amplifier stage. Network calculation results in a value of 20,000 ohms for the series resistance with a power loss of only 6 db. Capacitors of 3.5 and 70 μf provide the required low-frequency time constants. Because the tantalytic capacitors in the network are polarized units, two of them are connected back to back to permit the flowing of bilateral currents. Germanium diodes are connected across each capacitor to shunt the reverse currents.

Power Amplification

The power amplifier section is designed to develop the required six watts with low distortion and the low output impedance necessary to reduce the servo motor corner frequency. When the motor is driven from a high-impedance source, the corner frequency is 2.5 cps. This frequency increases to 5 cps when the motor is driven from a 200-ohm source, which is less than 1/10 the stalled motor impedance.

The common-collector stage is a linear voltage amplifier for all voltages over a few tenths of a volt. Thus no biasing is necessary and a standby current drain for the four transistors of only a few milliamperes is caused by the transistor leakage current. Inasmuch as this current is thermally generated within the transistors its

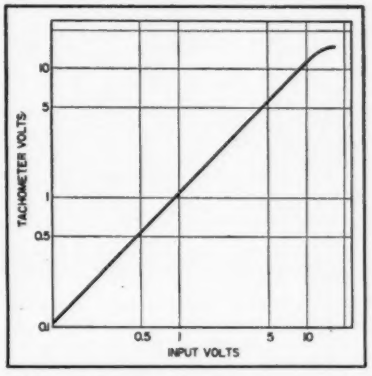


FIG. 3—Transfer characteristic curve is linear over range of better than 100 to 1

magnitude will vary with temperature. When the transistors are at room temperature it will be 1 or 2 ma. But when the transistors are heated by internal power dissipation or increased ambient temperature it may temporarily increase to 50 ma.

The output impedance of a common-collector stage is approximately equal to the driving impedance of the preceding stage divided by the current gain of the transistor. Since two common-collector stages are cascaded together in this circuit the output impedance is equal to the driving impedance seen by the first transistor divided by the product of the current gains of both transistors. This is an impedance reduction of about 200 for the transistors used. Since the voltage gain is nearly one this results in a power gain of about 22 db.

Two resistors of 220 ohms each are connected from base to emitter of each power transistor to improve the thermal stability of the circuit. If they were not present the thermal current generated within the transistor would cause its base to become slightly positive with respect to the emitter. This in turn would cause the medium-power driver transistor to be cut off, eliminating the stabilizing effect of its normally low output impedance. The result at best would be reduced overall efficiency and it could result in thermal runaway and destruction of the transistor.

A medium-power class-A stage supplies power for the output. It has a maximum output power of 50 mw and a standby dissipation of 150 mw. Negative feedback reduces the output impedance and improves stability. Low output impedance is desirable to prevent changes in motor impedance from reflecting back through the common-collector stages and influencing the gain.

The output impedance with feedback is 2,400 ohms at the driver transformer primary as compared to 9,000 ohms without feedback. The power gain of this stage is 28 db resulting in a total power amplifier section gain of 52 db.

Negative Feedback

A negative feedback loop around the power amplifier section further reduces the system output impedance and provides part of the 90-deg phase shift required for operation of the motor.

Satisfactory stability is obtained by designing the feedback loop to supply a 60-deg phase shift and detuning the output of the modulator transformer to obtain the remaining 30-deg shift. The 6-db feedback reduces the output impedance from 700 to 200 ohms as seen at the 110-v secondary of the output transformer. This is a driving impedance of less than one-tenth the stalled motor impedance and represents a sufficiently stiff source for proper motor operation. The complete system transfer characteristic is shown in Fig. 3.

Generating Characters

SUMMARY —— Analog device displays alphabetic or numeric characters on face of cathode-ray tube by deflecting spot to trace out each desired character smoothly and continuously. Necessary X and Y deflection voltages for scope are obtained by Fourier synthesis technique that involves combining sine and cosine terms of first five harmonics of 30-kc fundamental frequency. Each character is traced in about 30 microseconds. Transistorized gated oscillators, flip-flop serial counters and emitter-followers feed ten toroidal transformers having one set of secondary windings for each character desired

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ALTHOUGH MANY PLANS have been devised in the past for scribing numeric and alphabetic characters on a scope face by spot deflection, a new analog circuit recently developed for this purpose has some advantages in both simplicity and versatility.

The Arabic octal numerals zero through seven each may be represented as a segment of a continuous closed curve given in cartesian coordinates by the equation $y = f(x)$. In general, y is a multivalued function of x, but the curve can be represented by two parametric equations: $y = f_1(t)$, $x = f_2(t)$ where $t_0 < t < t_1$ and where f_1 and f_2 are single-valued functions of t. If t is the time, then these functions define the continuous motion of a point along the curve. They must be single-valued functions, since the spot cannot be in two different positions at the same time.

If the tangential speed of the point is known at all times (specifically, if it is constant), then the parametric equations are defined by $y = f(x)$. Thus, if $f_1(t)$ and $f_2(t)$ represent the voltage waveforms that are applied to the y and x deflection amplifiers, the desired curve will be traced on the scope face. Since most of the symbols are not closed curves, an unblanking function must be provided to intensify the desired segment.

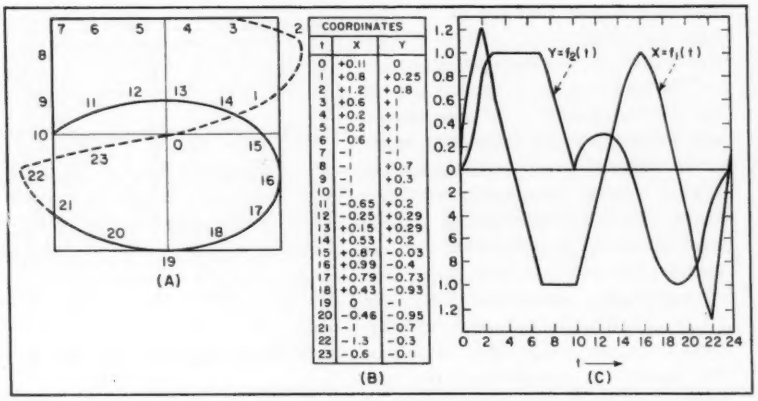


FIG. 1—Waveforms at right, obtained by measuring coordinates of numeral five as at left, will generate this numeral when applied to X and Y inputs of oscilloscope

Equations for Numerals

A function of the type just described can be expanded into a Fourier series of sine and cosine terms:

$$f_1(t) = A_0 + A_1 \sin \omega t + B_1 \cos \omega t + A_2 \sin 2\omega t + \ldots .$$

where $\omega = 2\pi (t_1 - t_0)$ and $t_0 = 0$. The expression $(t_1 - t_0)$ is the time required for the spot to trace the entire closed curve.

The procedure for finding the coefficients A_n, B_n is as follows: The desired character is drawn on graph paper as in Fig. 1A, including a retrace segment which closes the curve. To ensure that all characters can use the same unblanking function, closed figures like zero and eight have redundant retrace segments tacked on as an appendix. Twenty-four points are laid off along the curve at roughly equal intervals the actual number being arbitrary. These points divide the time $(t_1 - t_0)$ into 24 equal intervals. The x and y coordinates of each point are tabulated as in Fig. 1B, with t_0 taken as the center of the retrace segment. These tabulated values represent the two functions $f_1(t)$ and $f_2(t)$, as plotted in Fig. 1C. These functions may be analyzed by any one of several graphical and numerical

for Cathode-Ray Readout

integration methods.

The method now used[1] is a purely graphical one where each x or y value is laid off as a vector at an angle equal to $(n\omega t)$. When these vectors are added head to tail, the projections of the resultant vector give the coefficients A_n, B_n. When the coefficients have been determined it is possible to synthesize desired waveforms by electrically adding sine and cosine waves of correct frequency and amplitude.

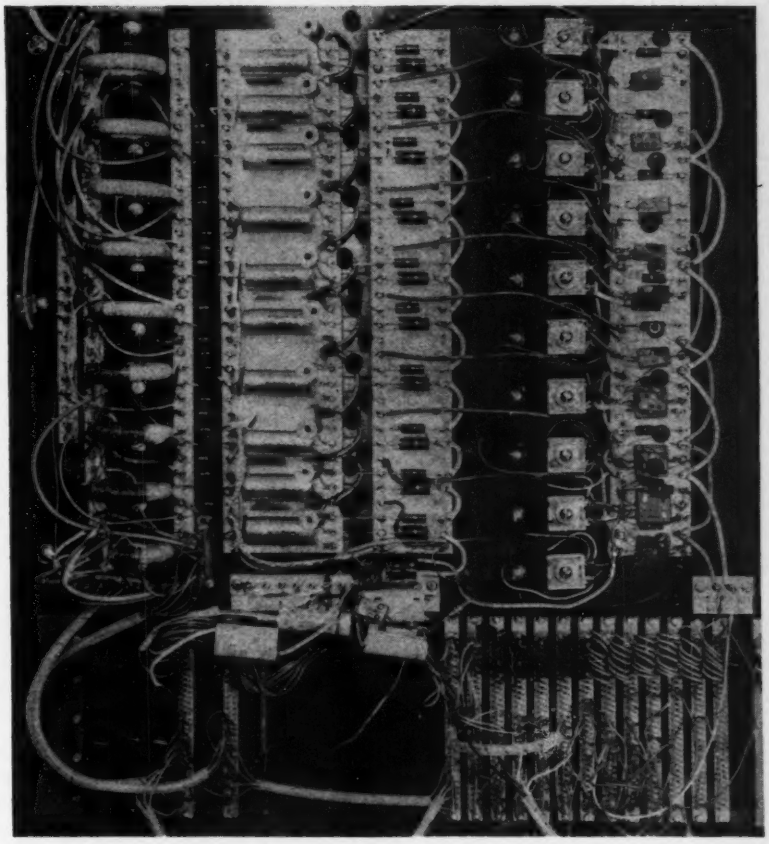
Synthesizing System

The circuit for synthesizing the desired voltage waveforms from artificially generated sine and cosine waveforms uses five harmonics with a fundamental frequency of 30 kc. Ten tuned circuits (five sine and five cosine) are simultaneously shock-excited into oscillation by a gate 33 microseconds wide to give one cycle of 30 kc, two cycles of 60 kc, three of 90 kc, four of 120 kc and five of 150 kc.

These ten signals are fed through emitter-follower buffers to the primaries of ten toroidal transformers. Secondaries are wound on these toroids, with direction of winding and number of turns determined by the sign and magnitude of the Fourier coefficients. When these secondaries are connected in series and one end of the series circuit is grounded, the desired voltage waveform appears at the other end.

Figure 2 is a complete block diagram of the prototype system. The circuit as depicted here will display the numerals 0 through 7, four rows deep (32 characters). This can be displayed on any oscilloscope having an external unblanking connection.

A 120-kc sine wave is fed into a clock generator which shapes the signal into a square wave. The prime side of the clock generator output is commutatively coupled to flip-flop F_1, the first of a chain of eight serial counters[2]. The logic levels used are +5 volts and −5 volts. The unblanking function is



Harmonic generator, with ten character-forming toroidal transformers in vertical row at left. Transistorized shock-excited oscillators are at right, buffer-emitters at center, and control and cycling circuitry is on plug-in cards sliding into grooves of lower compartment

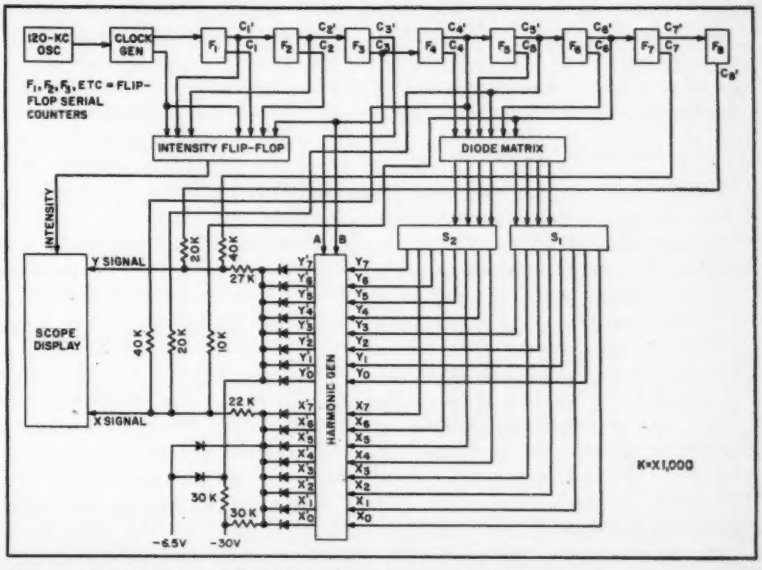


FIG. 2—Block diagram of Fourier-synthesis character generator

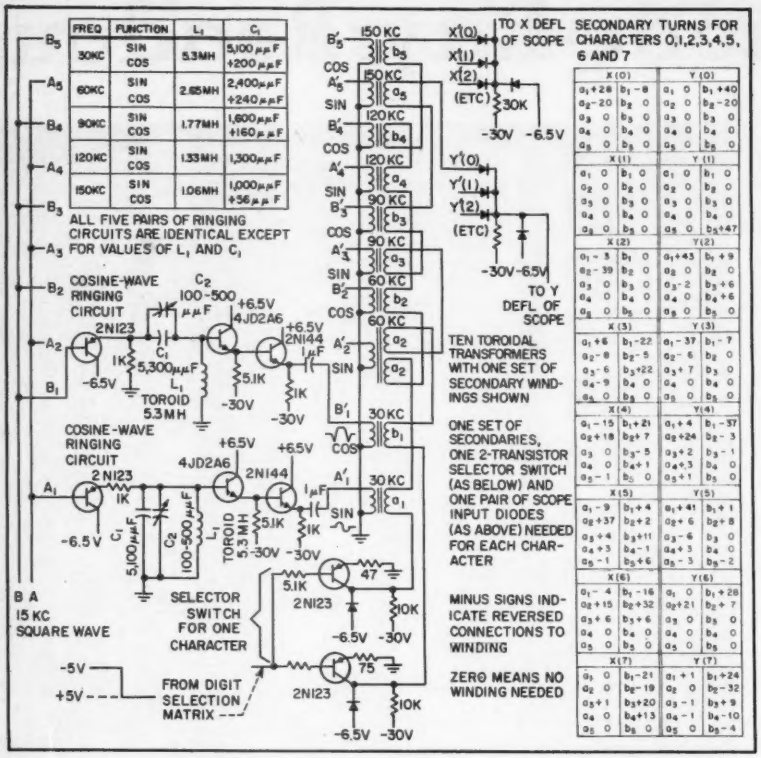


FIG. 3—Circuit of harmonic generator for producing one character. Each additional character requires additional selector switch and additional set of toroidal transformer secondaries feeding scope input terminals as at top of diagram

generated in the intensity flip-flop, controlled by F_1, F_2, F_3 and the clock generator. The intensity pulse starts one-half clock cycle or about 4 microseconds after the prime side of flip-flop F_3 goes up and ends 4 microseconds before the same point goes down. This unblanks that segment of the Lissajous pattern which forms the desired character. One-fourth of this continuous closed curve is blanked.

Harmonic Generator

Flip-flop F_3, which shock-excites the ringing circuits in the harmonic generator of Fig. 3, is operating at exactly one-half the rate of the fundamental frequency used in the synthesis. The ringing period of the shock-excited oscillators occurs during the time the prime side of flip-flop F_3 is high. Since the fundamental frequency of 30 kc is twice the frequency of flip-flop F_3, one complete cycle goes into the slot before the ringing is ended by a change of state in F_3.

In like manner, there are two cycles of the second harmonic, three of the third, etc., all initiated and terminated at the same time. The sine waves and the cosine waves are generated in parallel-resonant and series-resonant circuits respectively. Input A in Fig. 3, which is connected to five sine-wave ringing circuits, is controlled by counter output C_3'. When C_3' goes up, the five input transistors connected to point A are cut off and the parallel resonant circuits composed of L_1, C_1 and C_2 in Fig. 3 ring at their respective frequencies (30, 60, 90, 120 and 150 kc). The output is a positive sine wave.

Damping of oscillations is small because of the high-Q powdered iron cores used for L_1. Input B, which is connected to five cosine-wave series ringing circuits, is controlled by flip-flop counter output C_3. These circuits oscillate at their resonant frequencies when the input transistor is on (point B low). Output is a negative cosine wave.

Since the ringing circuits are cut off at a point in the cycle exactly corresponding to the turn-on point, there is no damping transient and the operation is not duty-cycle sensitive. In other words, at the instant of turn-off the voltage on the capacitor and the current through the inductor are very near to the quiescent values. This would be exactly true except for the losses during ringing. It is only necessary to leave the circuit off long enough for this small amount of lost energy to be replaced.

The values of L and C in Fig. 3 are determined by setting $\sqrt{L/C} = R$ where R is the critical damping resistor, arbitrarily chosen as 1 k, L and C are unknown.

Solving first for L in terms of C and substituting this result in the equation $\sqrt{LC} = 2\pi f$, then solving for C, L can then be found from either equation. Trimmer C_2 has a range of from 100 $\mu\mu$f to 500 $\mu\mu$f and is adequate for adjusting the ringing circuit for any L and C inaccuracies.

Each ringing circuit is followed by an emitter-follower buffer amplifier which also drives the base of a power transistor in an emitter-follower amplifier configura-

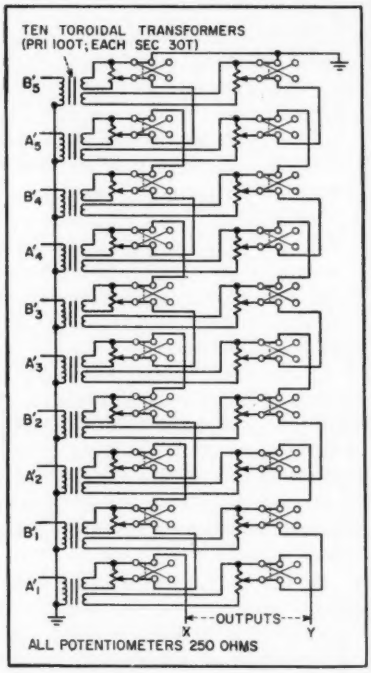


FIG. 4—Simulator circuit in which potentiometers duplicate changing of turns on toroidal transformer secondaries, for trying out effects of various combinations of coefficients before putting windings on transformers permanently

tion. The output of the power transistor is coupled through a 1-μf capacitor to the primary of a toroidal transformer.

Referring to Figs. 2 and 3, X_0 and X_0', X_1 and X_1', etc, or Y_0 and Y_0' or Y_1 and Y_1', etc, on the harmonic generator block are the terminals to the series secondary windings on the toroidal transformers. Every time flip-flop F_3 cycles, these circuits have $f_1(t)$ and $f_2(t)$ waveforms on them. These secondary waveforms will not, however, be passed through the OR diodes to the scope unless the X and Y inputs are high.

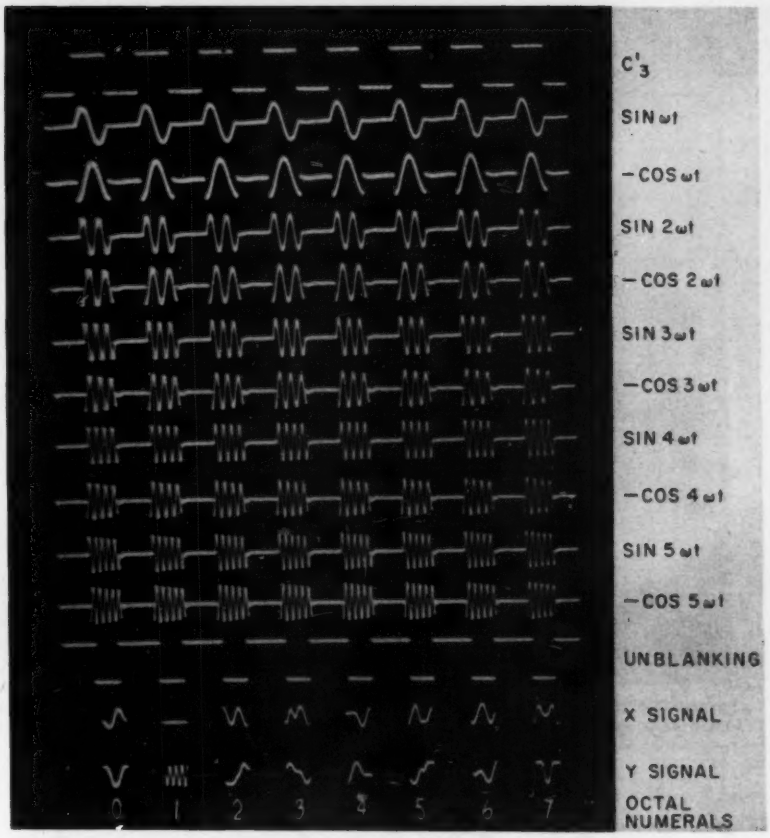
The d-c levels of the unprimed ends of the secondary windings (X and Y in Fig. 2) are controlled by the state of their associated switches. When a switch output is high, the corresponding OR diode (Fig. 2) is forward-biased and the signal on that particular secondary is transferred to the scope.

Transistorized Switch Circuit

The switches are *pnp* transistors in the grounded-emitter configuration shown in Fig. 3. The collector controls the d-c level of the associated secondary winding in the harmonic generator. The base inputs have two states. When the base is high the collector is at -6.5 v and its associated secondary winding sees an open diode in the OR circuit preceding the scope (Fig. 2). When the base is low, the collector will be at ground or some small negative voltage, determined by the fixed resistor at the emitter. The purpose of this resistor is to adjust the level of the synthesized waveform $f_1(t)$ and $f_2(t)$.

In the original graphical analysis for $f_1(t)$ and $f_2(t)$, no attempt was made to compute the d-c Fourier coefficient A_0 since the zero frequency cannot be accommodated in the transformers. Therefore, some of the numerals would be displaced from their proper relative positions on the scope face. It is this discrepancy in the d-c level that is adjusted by the resistors.

The diode matrix selects the number to be displayed under control of flip-flops F_4, F_5 and F_6. A different number will be displayed during each unblanking pulse. Only one output is low at any time. This voltage turns on a pair of switching transistors in the selection-switch package.



Waveforms involved in generation of eight Arabic numerals by synthesis

The four resistors on the X input of the scope (Fig. 2) are used to generate an eight-step ladder of voltages at the same rate as the unblanking function, thus displacing each numeral consecutively.

The three resistors on the Y input, in conjunction with the slower-running flip-flops F_7 and F_8, displace the whole row of eight numbers vertically four times.

Toroid Construction

The ten toroidal transformers in the harmonic generator each consist of a General Ceramics F-108 ferrite core with 100 turns machine-wound evenly around the entire toroid, then covered with insulating tape. With the ten cores mounted at right angles to the panel, the secondaries can be placed on by hand as they are needed. A set of series secondaries consists of a single length of No. 24 Formvar wire wound through and around the ten toroids. Ample space is available to accommodate additional windings on the toroids for generating other characters.

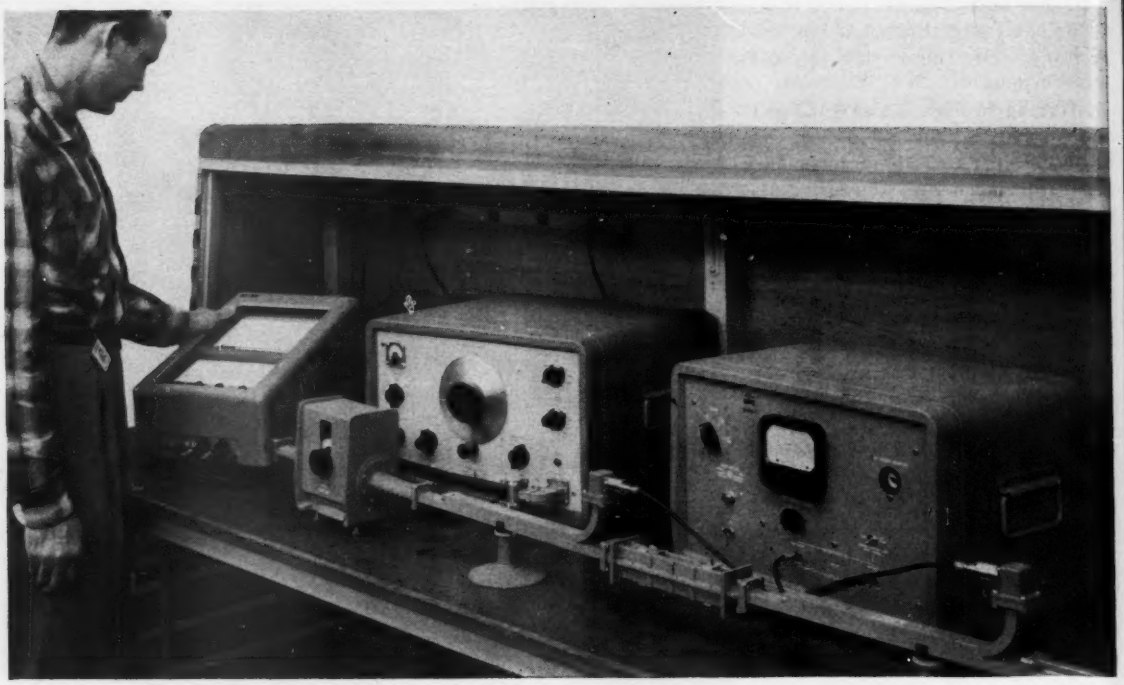
A simulation device was built to try the effect of various combinations of coefficients in generating various characters. The circuit is shown in Fig. 4. The toroid primaries are substituted for the toroids in the harmonic generator, and the 250-ohm potentiometers are adjusted to the proper coefficient values. The resulting character can then be observed.

The research work on this project was supported jointly by the Army, Navy and Air Force under contract with Massachusetts Institute of Technology.

References

(1) T. C. Blow, Graphical Fourier Analysis, ELECTRONICS, p 194, Dec. 1947.

(2) R. H. Baker, Boosting Transistor Switching Speed, ELECTRONICS, p 190, March 1, 1957.



Reverse-loss scatter coefficient for waveguide ferrite isolator is measured and recorded. Sweep oscillator feeds waveguide system, where incident and scattered signals are sampled by couplers, detected and compared in ratiometer

SHF Frequency Sweeper

SUMMARY —— Swept-frequency signal source using backward wave oscillator tube offers sweep rates from 40 mc to 400 kmc in the microwave region between 8.2 and 12.4 kmc. Rapid wide-range evaluations of reflection, gain and attenuation are possible, as well as permanent records of measured data on an ink recorder. Sweep width is continually adjustable from 3 mc to 4.2 kmc and unit may be modulated with a-m or f-m

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SWEPT-FREQUENCY measurements obtained directly by mechanical methods have limited ranges of sweep speed and are subject to wear, while electrically-swept oscillators such as reactance-tube or klystron systems suffer from limited sweep range.

The backward-wave oscillator tube overcomes these objections since it is easily voltage-tuned and covers at least a full waveguide frequency range.

Application

Swept-frequency measurement of reflections from transmission junctions or transfer characteristics of microwave devices can supplant tedious manual data-taking in design or production test. The convenience of this method permits more frequent testing of operational equipment and consequently greater reliability.

A schematic diagram of a typical X-band backward-wave oscillator tube is shown in Fig. 1. The cathode-to-anode voltage of the electron gun determines the beam current passing through the tube. The cathode-to-helix voltage determines the velocity of the electrons

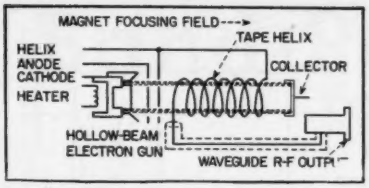


FIG. 1—Schematic representation of helix-type backward wave oscillator circuit

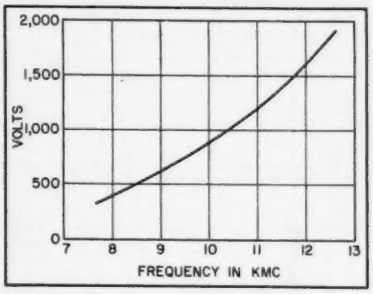
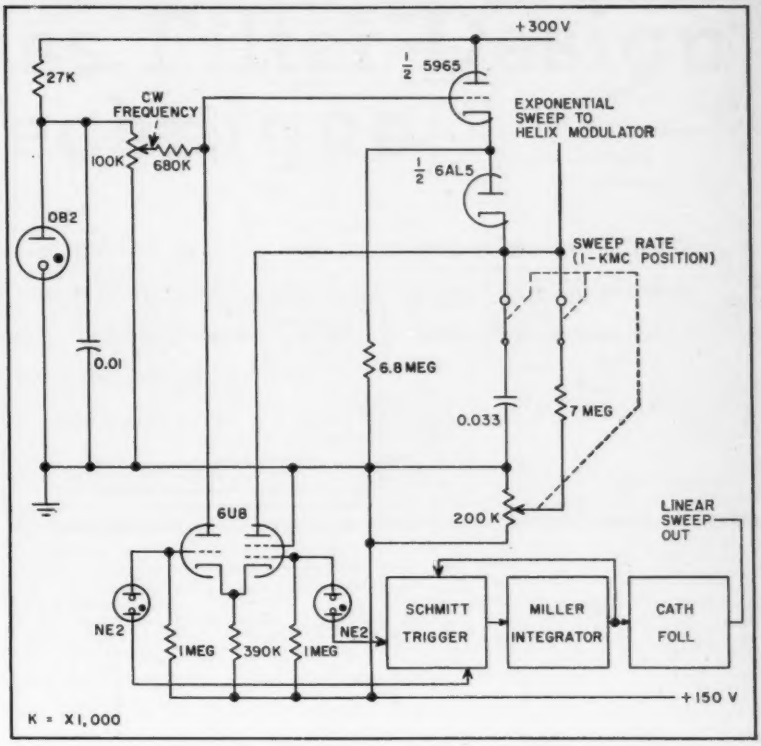


FIG. 2—Voltage tuning curve for a typical backward wave oscillator tube

FIG. 3—Simplified schematic of exponential sweep generator providing helix sweep voltage



Uses Backward Wave Tube

passing through the helix and in turn fixes the frequency of operation. The collector at the helix far end collects the beam current and radiates the heat generated.

The cathode is a ring and the subsequent electrodes have aligned annular openings. The electron gun thus forms a hollow electron beam, the form that is most effective in backward-wave interaction with a helix circuit. The electron beam is confined by a strong axial magnetic field so that few or no electrons touch the helix. A typical tube uses a solenoid producing a field of 800 gauss, which is current-regulated for frequency stability.

The backward-wave tube can also be used as a narrow-band regenerative amplifier at low beam currents. For this mode of operation the signal is impressed on the helix at the collector end. The signal travels toward the gun end of the tube with linear gain against distance at first, but then levels off. The velocity modulation and resultant bunching of the electron beam increases in the same manner in the opposite direction.

When a certain beam current is reached, oscillation starts. For this type of operation the collector end of the tube is provided with a tapered film-on-glass termination, and the useful output is taken from the gun end of the helix by a coaxial line.

Voltage Tuning Characteristic

The voltage tuning characteristic of a typical backward-wave oscillator tube resembles the curve of an increasing exponential as shown in Fig. 2. Checking the characteristics of a number of experimental and production tubes confirms the closeness of this approximation.

The sweep voltage will cause the frequency of oscillation to vary linearly with time. Since a decaying exponential can be formed with passive elements alone, this characteristic is used in a downward sweep.

This sweep must be between fixed voltages corresponding to the frequency limits of the band. Then the slope is adjusted at each end of the band. The asymptote of the exponential decay determines the ratio of the initial and final slopes and is adjusted to give best linearity. The R-C time constant is then adjusted to give the desired sweep time.

If the capacitor is charged to any voltage within the frequency limits and subsequently allowed to discharge, it will follow the established decay curve and generate the necessary waveform for linear frequency sweep. This sweep is generated at low amplitude by the circuit of Fig. 3. The output of this sweep generator is used as the reference voltage in the helix high-

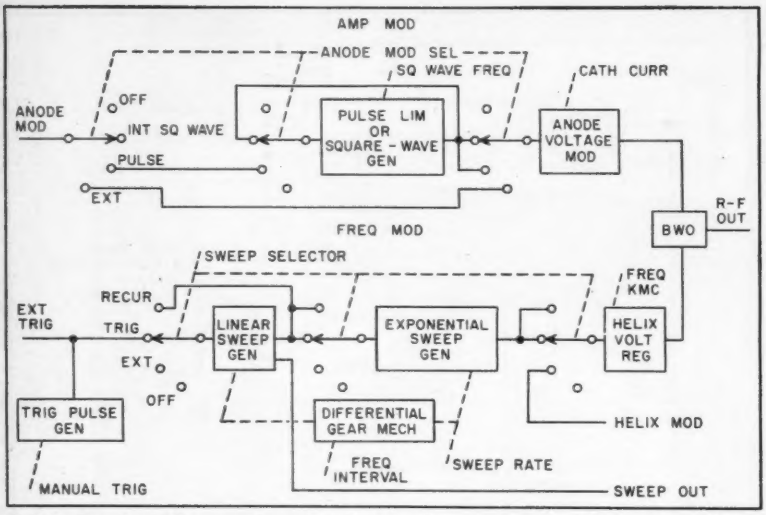


FIG. 4—Functional diagram of complete backward-wave sweep oscillator and modulators

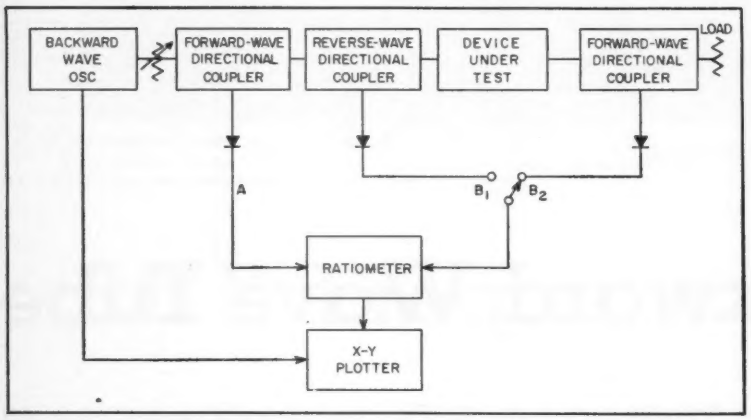


FIG. 5—Block diagram of setup for measuring reflection and transmission coefficients

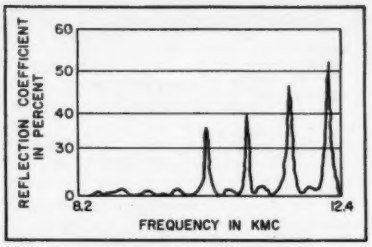


FIG. 6—Reflection-coefficient curve of waveguide window shows higher-order mode resonances

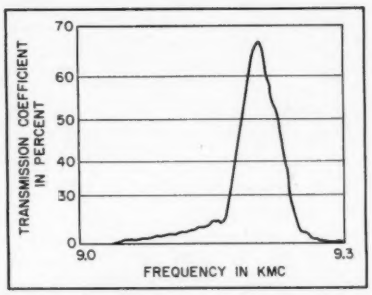


FIG. 7—Transmission-coefficient curve of cavity filter obtained by method of Fig. 5

voltage supply and the sweep is amplified and applied to the tube helix when swept operation is desired.

Sweep Circuits

For sweeping across parts of the band, a given R-C combination will determine the sweep rate ($\Delta f/\Delta t$) at all points across the band. The potential to which the capacitor is charged determines the frequency at which the sweep begins. By sweeping over a limited time τ a swept frequency interval Δf is the product of the sweep rate and the sweep time.

The panel selectors may be made directly reading in the more useful quantities of sweep rate and frequency interval if the sweep-time control is driven through a differential by the rate and interval selectors.

The relationship of controls and modulation circuits is shown in Fig. 4. Accompanying the frequency sweep there is a linear sweep that can be used as a time base for oscillograph display or recording on an X-Y plotter of any measured quantity.

Swept Frequency Measurements

The oscillator can be square-wave modulated at frequencies from 400 to 1,200 cps during both single or swept-frequency measurements, for use with tuned amplifiers or ratiometers. Pulse or sine-wave modulation also can be applied to the anode for level modulation. A pulse rise time of one μsec can be obtained.

The external level modulation is a direct-coupled circuit that can be used for output level stabilization during frequency sweeping. The backward-wave tube exhibits "frequency pushing," which is a small change of frequency for beam current changes. This means that current modulation will produce both a-m and f-m.

The block diagram of a sweep oscillator arranged to make reflection coefficient measurements on waveguide ports is shown in Fig. 5. One variation of this method is to use the same equipment to make transfer-characteristic measurements on such devices as filters, ferrite isolators, amplifier tubes and waveguide junctions.

Multimode Transmission Devices

Multimode transmission lines and filters suffer from loss and spurious responses respectively due to inadvertant couplings to undesired modes. These deficiencies in constructed units can be evaluated by either reflection or transmission-coefficient measurements over the frequency range of interest.

A reflection-coefficient measurement on a terminated multimode transmission line fed by single-mode rectangular guide is shown in Fig. 6. Similarly Fig. 7 shows a transmission-coefficient plot for a TE_{01} filter.

Band-Pass Filter Design Technique

SUMMARY —— Universal curves provide design information for Butterworth and Tchebycheff stagger-tuned filter networks for band-pass amplifiers. Required number of stages, center frequency, cut-off frequencies, and stage gain requirements can be determined

By D. R. J. WHITE* Research Department, Avion Division, ACF Industries, Inc., Alexandria, Va.

STAGGER-TUNED band-pass filters employing electron tubes or transistors as buffer amplifiers can be readily designed using universal design curves presented here. These data can be used for one through six stages of tuned band-pass amplifiers providing either a maximally-flat (Butterworth) or 1-db ripple (Tchebycheff) response.

To use these data, amplifiers and circuitry to be designed must be reducable to a form shown in Fig. 1. The amplifiers may be electron tubes, transistors, magnetic amplifiers, or the like. Their performance, however, must be such that they effectively decouple each of the tuned circuits from the others.

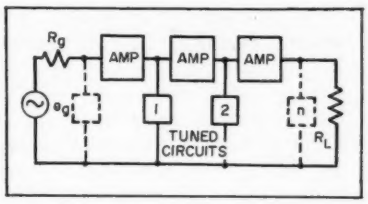


FIG. 1—Typical band-pass amplifier with isolation between filter stages

Configurations

For an amplifier having a band-pass response, each network is an RLC parallel-tuned circuit connected across a node pair. From a physically realizable point of view the R of each stage includes the dissipative loading effect of all elements connected across the tuned circuit at the respective node such as plate load resistors, transient-time grid loading, and loading due to finite values of the quality factor of the coils in each configuration.

If the desired input and/or output networks are to have tuned circuits then the value of R must include the loading due to R_G or R_L respectively. Similarly, the value of each C includes wiring and stray capacitance, input and output capacitance of each amplifier, and effective parasitic shunt capacitance of the coil.

Tuned-Amplifier Specifications

The following information concerning the band-pass amplifier is required: center frequency, either width of pass-band, B, or loaded Q factor, Q_L, either the 60-db bandwidth B_{60}, or skirt selectivity in db

*Now with American Machine & Foundry Co.

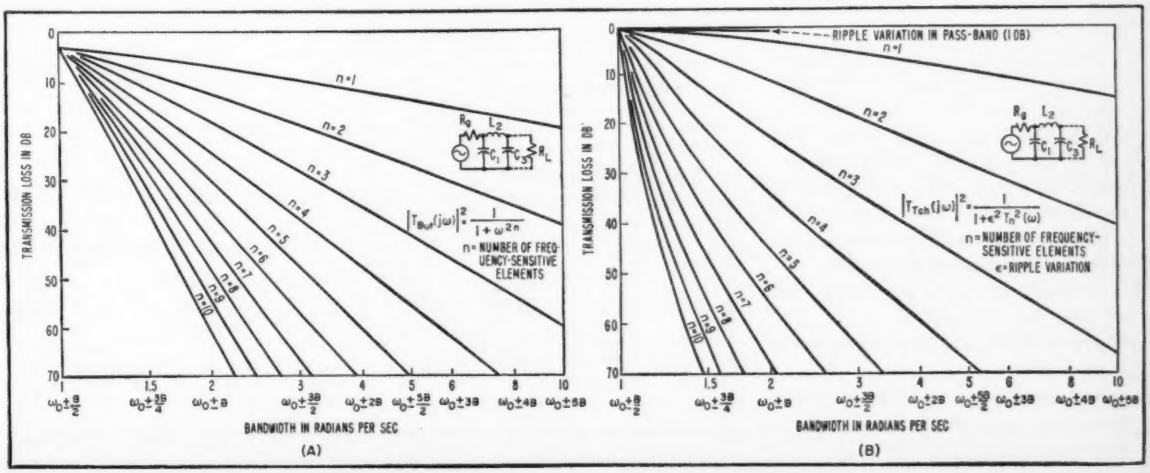


FIG. 2—Transmission loss with frequency for Butterworth (A) and Tchebycheff (B) response

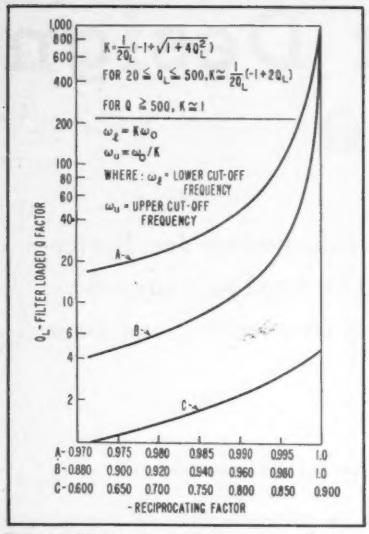

$K=\frac{1}{2Q_L}(-1+\sqrt{1+4Q_L^2})$
FOR $2 \leq Q_L \leq 500, K \cong \frac{1}{2Q_L}(-1+2Q_L)$
FOR $Q \geq 500, K \cong 1$
$\omega_\ell = K\omega_0$
$\omega_0 = \omega_0/K$
WHERE: ω_ℓ = LOWER CUT-OFF FREQUENCY
ω_u = UPPER CUT-OFF FREQUENCY
Q_L - FILTER LOADED Q FACTOR
A
B
C
A- 0.970 0.975 0.980 0.985 0.990 0.995 1.0
B- 0.880 0.900 0.920 0.940 0.960 0.980 1.0
C- 0.600 0.650 0.700 0.750 0.800 0.850 0.900
- RECIPROCATING FACTOR

FIG. 3—Plot of reciprocating factor against loaded Q factor

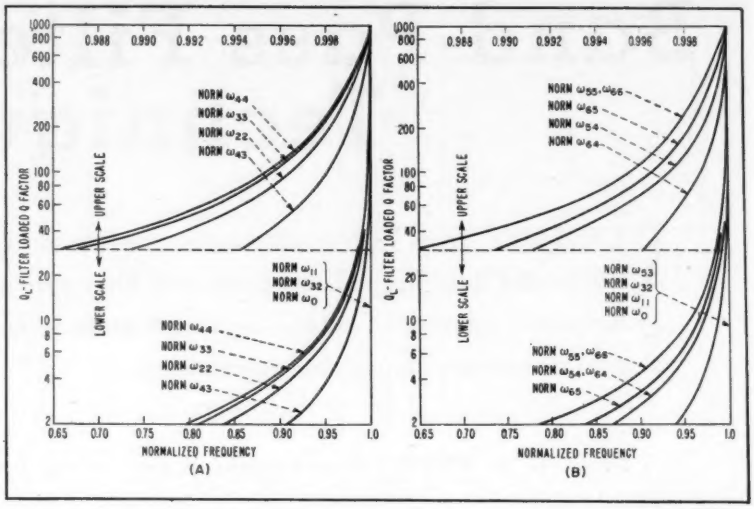


FIG. 4—Normalized frequencies of Butterworth response plotted against filter loaded Q factor for one through six tuned stages

per bandwidth and the allowable pass-band ripple variation.

Overall voltage or power gain at center frequency is not required. The first two items are self-explanatory. The skirt selectivity and pass-band ripple variation are required to establish the number of stages needed to realize the desired signal rejection just outside the pass band.

Design Procedure

Having specified bandwidth and skirt selectivity the required number of filter stages may be ascertained from the low-pass prototypes of Fig. 2. Conversely, these graphs are useful in establishing skirt selectivities in terms of allowable or fixed number of stages.

Next, tuned frequency and loaded Q-factor of each stage must be determined. Figure 3 is a plot of the normalized upper and lower 3-db cut-off frequencies for the Butterworth response and the 1 db cut-off frequencies for the Tchebycheff 1-db ripple response plotted against overall filter loaded Q_L factor.

These frequencies are: lower cut-off angular frequency: $\omega_\ell = w_0 k$; upper cut-off angular frequency: $\omega_u = w_0/k$
where ω_0 is the band-pass center frequency, $\omega_0 = \sqrt{\omega_u \omega_\ell}$ in radians per second, and k is the reciprocating factor determined from Fig. 3.

Figure 4 depicts the normalized angular frequencies, norm ω_{nm}, to which each stage must be tuned to give a Butterworth response for 1 through 6 stages. Figure 5 is the corresponding case for the Tchebycheff response having a 1-db ripple variation in the pass band:

$$\omega_{nm} = \frac{\omega_{nm}}{\omega_0}$$

where ω_{nm} is the actual angular frequency to which the m stage of an n-stage stagger-tuned network is tuned.

Figures 6A and 6B depict the Q_{nm} factor of each individual stage for a filter having an overall Butterworth response of Q_L. Figure 7 corresponds to the Tchebycheff response of 1-db ripple variation.

Examples

As an example, suppose it is desired to design an i-f amplifier having stagger-tuned stages and providing a Butterworth response centered at 60 mc, a bandwidth of 5 mc, a signal rejection of at least 45 db at 60 ± 7.5 mc, and an over-

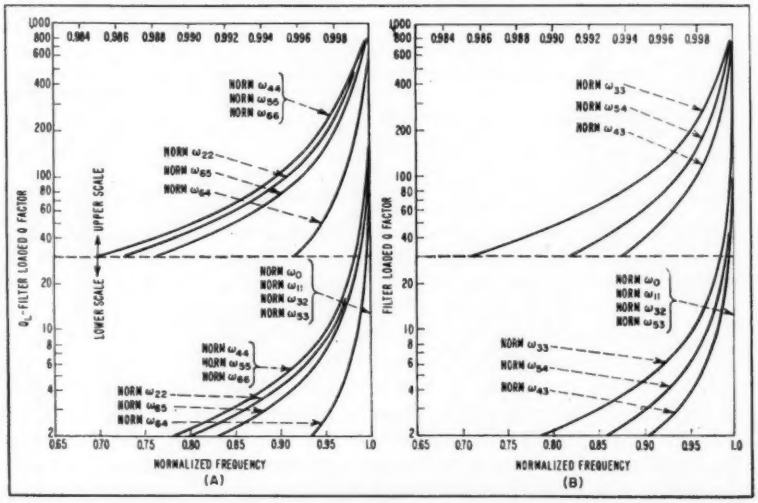


FIG. 5—Normalized frequencies of Tchebycheff response plotted against filter loaded Q factor for one through six tuned stages

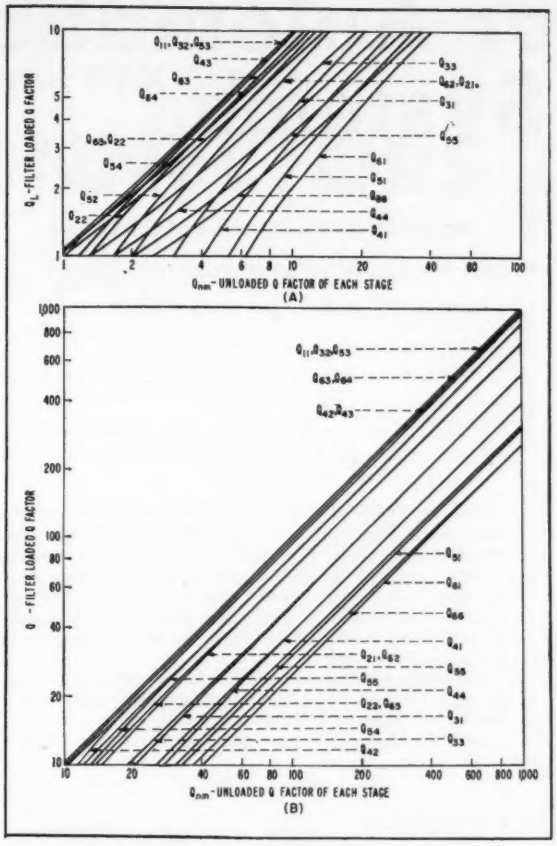

Q_L - FILTER LOADED Q FACTOR
Q_{nn} - UNLOADED Q FACTOR OF EACH STAGE
(A)
Q_L - FILTER LOADED Q FACTOR
Q_{nn} - UNLOADED Q FACTOR OF EACH STAGE
(B)

FIG. 6—Unloaded Q factor of individual stages of Butterworth response filter compared to loaded Q for Q_L less than 10 (A) and for Q_L greater than 10 (B)

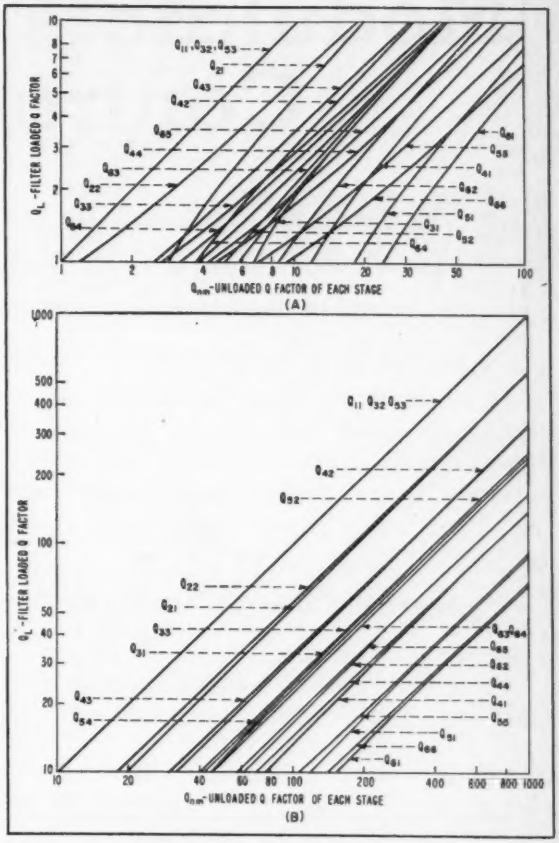

Q_L - FILTER LOADED Q FACTOR
Q_{nn} - UNLOADED Q FACTOR OF EACH STAGE
(A)
Q_L - FILTER LOADED Q FACTOR
Q_{nn} - UNLOADED Q FACTOR OF EACH STAGE
(B)

FIG. 7—Unloaded Q factor of individual stages of filter having Tchebycheff response compared to loaded Q for values of Q_L less than 10 (A) and greater than 10 (B)

all gain of 100 db using premium subminiature electron tubes.

From Fig. 2A, the required number of stagger-tuned stages to give a 45 db rejection at 60 ± 7.5 mc = $\omega_o \pm 3B/2$ is 4.8. Five stages (n = 5) will be used since only integer numbers are possible.

The loaded Q_L factor of the amplifier response is 60/5, or 12. From Fig. 3, the 3 db cut-off frequencies (expressed in mc rather than in radians) are:

$\omega_l = \omega_0 k = 60 \times 0.959 = 57.55$ mc
$\omega_u = \omega_0 / k = 60/0.959 = 62.55$ mc

Center Frequency

From Fig. 4B, the center frequency to which each stage is tuned is

norm $\omega_{55} = 0.962$ $\omega_{55} = 0.962 \times 60.0 = 57.7$ mc
norm $\omega_{54} = 0.976$ $\omega_{54} = 0.976 \times 60.0 = 58.6$ mc
norm $\omega_{53} = 1.000$ $\omega_{53} = 1.000 \times 60.0 = 60.0$ mc
norm $\omega_{52} = 1/0.976$ $\omega_{52} = 1.025 \times 60.0 = 61.5$ mc
norm $\omega_{51} = 1/0.962$ $\omega_{51} = 1.040 \times 60.0 = 62.4$ mc

The required corresponding Q-factors from Fig. 6B are

$Q_{55} = 37.0$ $B_{55} = \omega_{55}/Q_{55} = 1.56$ mc
$Q_{54} = 14.5$ $B_{54} = \omega_{54}/Q_{54} = 4.04$ mc
$Q_{53} = 12.0$ $B_{53} = \omega_{53}/Q_{53} = 5.00$ mc
$Q_{52} = 15.0$ $B_{52} = \omega_{52}/Q_{52} = 4.10$ mc
$Q_{51} = 40.0$ $B_{51} = \omega_{51}/Q_{51} = 1.56$ mc

Gain—Bandwidth

With a desired overall gain of 100 db and using 5 stages, the gain per stage is 20 db, or a voltage gain of 10. The resulting gain-bandwidth product required of each stage is 10 × 5 mc = 50 mc. This is easily realized, such as with the CK 5702 WA type premium subminiature electron tube.

Nominally, for buffer-separated networks using electron tubes as intermediate frequencies, individual stage Q factors in excess of about 50 are impractable. This is because physical realizability of the tuned networks becomes difficult due to the high plate load resistors required and transient loading effects.

The author wishes to express his gratitude to James H. Mills, Jr. for his calculations for the universal design curves, C. L. Ranck for his calculations in connection with the synthesis of the Butterworth and Tchebycheff transfer functions and A. Feiner, project engineer of RADC, under whose sponsorship this subject has been investigated in Contract No. AF30 (602)-1449.

Bibliography

E. A. Guillemin, A Summary of Modern Methods of Network Synthesis, *Advances in Electronics*, **2**, 216, Academic Press Inc., N. Y., N. Y., 1951.

Van Voorhis Microwave Receivers, **23**, *Rad Lab Series*, p 162, McGraw-Hill Book Co., New York, 1948.

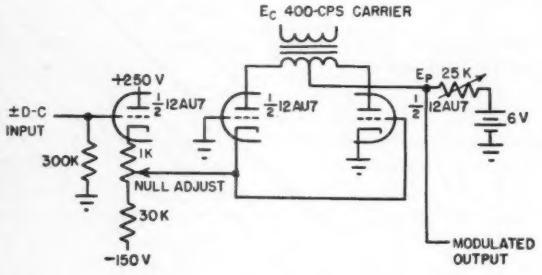
D. R. J. White, Synthesis of Two-Terminel-Pair Networks, and Filter Design Procedures, *Interim Engineering Report for Filter Study*, RADC Contract No. AF 30 602)-1949, 1 March 1956—31 May 1956.

D. R. J. White, Charts Simplify Passive L-C Filter Design, ELECTRONICS, **30**, p 160, Dec. 1957.

Modulators for Automatic Control Systems

SUMMARY —— Survey of low-frequency modulation systems used in amplification of d-c signals and equalization of a-c signals to give control system desired performance characteristics. Typical applications are described

By L. S. KLIVANS Engineering Specialist, Radioplane Co., Van Nuys, Calif.

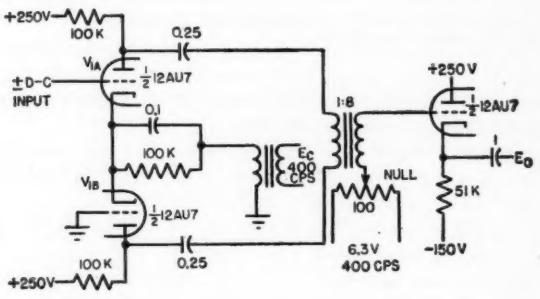


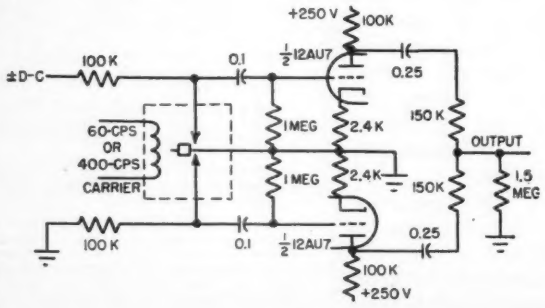
VARIABLE PLATE RESISTANCE MODULATOR—Increasing magnitude of carrier voltage decreases signal-to-noise ratio, but increases modulated output. With E_p = 0.5 v, and E_c = 0.25 v rms, 400 cps, the output is linear with up to ±2 v d-c input, and reaches a magnitude of 0.2 v rms. The null level is 2 to 5 millivolts. The null level is second harmonic of quadrature phase, while the large signal output is a low distortion sine wave.

Applications mainly limited to modulation of error signals, but may be used for open-loop applications with suitable filtering to increase signal-to-noise ratio. Tube characteristics differ from unit to unit at low plate voltages

BALANCED TRIODE SINE-WAVE MODULATOR—This is one of the best types of modulators available to obtain sinusoidal output without filtering. Input voltages of ± 3 v d-c give linear modulated output of 0.25 rms, with a carrier voltage of 0.6 rms. Increasing carrier voltage increases magnitude of linear output voltage but also raises null level. Null signal with 0.25 v rms carrier voltage is less than 1 mv, and is mainly composed of second harmonic, quadrature phase. Excellent long-time drift stability, less than 1 mv per hour referred to the output.

Can be used for either open loop or error signal modulation when high input impedance and a low-distortion sinusoidal output is required For applications where addition of subtraction from other sinusoidal signals is required





ELECTROMECHANICAL SWITCH MODULATOR—This circuit utilizes a chopper operated by a 60 or 400-cps carrier. This modulator has large signal-to-noise ratio and is only limited by contact rating as to input swing.

The amplifier shown is designed to further reduce the output signal null level by balancing out the zero input signal. Null levels can be maintained in the microvolt region by proper shielding. For circuit shown, ± 2 volts d-c input will produce 4.25 v rms output with a signal-to-noise ratio of 7,000 to 1. Long-time drift stability less than one millivolt referred to the output. Applications for this type of modulator include modulation of strain gauge or low-level transducer signals

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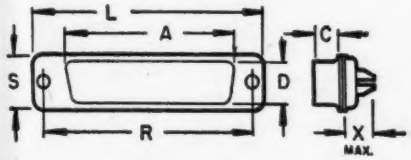
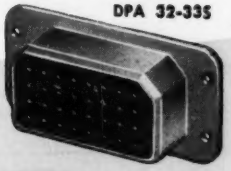


size	A	C	D	L	R	S	X	weight
DA-15P	1 1/64	13/64	23/64	1 17/32	1.312	31/64	5/16	.013
DA-15S	1 3/32	13/64	5/16	1 17/32	1.312	31/64	5/16	.014
DB-25P	1 5/16	13/64	23/64	2 5/64	1.852	31/64	5/16	.023
DB-25S	1 33/64	13/64	5/16	2 5/64	1.852	31/64	5/16	.031
DC-37P	2 13/64	13/64	23/64	2 23/32	2.500	31/64	5/16	.035
DC-37S	2 11/64	13/64	5/16	2 23/32	2.500	31/64	5/16	.035
DD-50P	2 7/64	13/64	15/32	2 5/8	2.406	39/64	5/16	.035
DD-50S	2 7/64	13/64	27/64	2 5/8	2.406	39/64	5/16	.040
DE-9P	43/64	13/64	23/64	1 13/64	.984	31/64	5/16	.011
DE-9S	41/64	13/64	5/16	1 13/64	.984	31/64	5/16	.012

FRACTIONS ±1/64 Tolerance DECIMALS ±0.005 Tolerance

32-34P

DPA 32-33S



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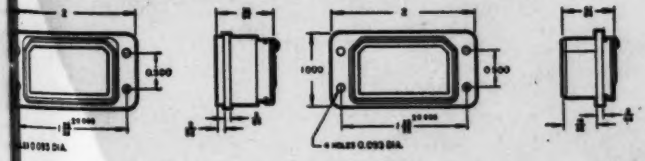

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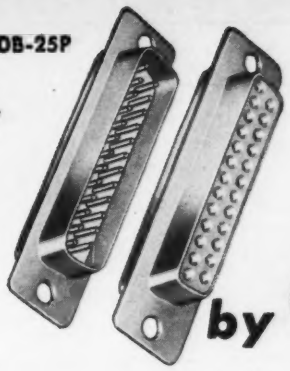

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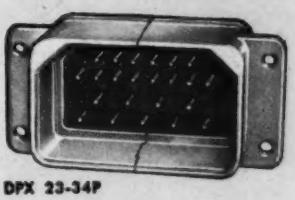

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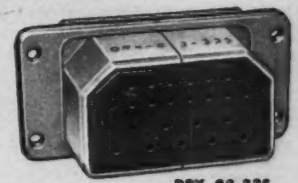

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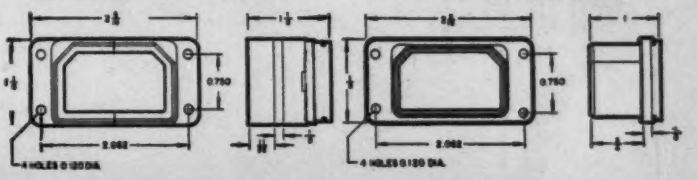

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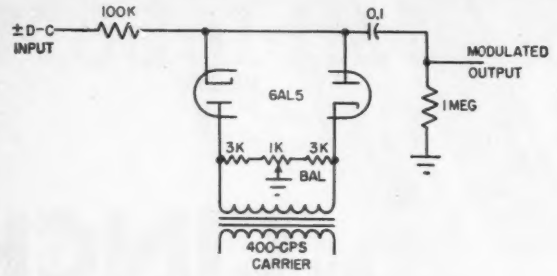
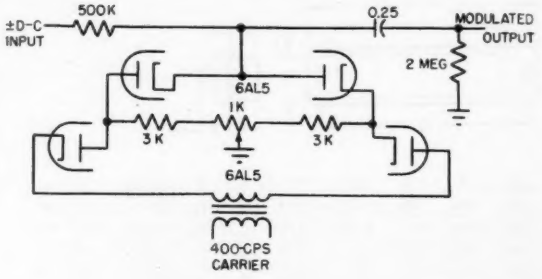
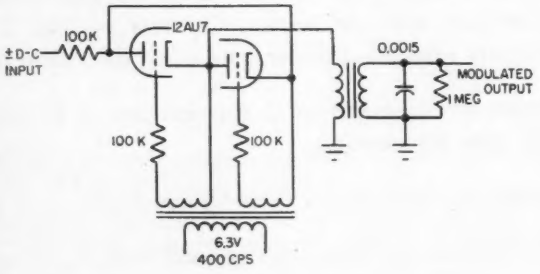


DUO-DIODE HALF-WAVE SWITCH MODULATOR—Similar in operation to electromechanical switch modulator except that electron-tube characteristics are utilized to replace chopper. Carrier voltage turns diodes on and off thus transferring d-c input signal to the output when diodes are not conducting. With a carrier voltage of 10-v rms, output is linear to 2 v with an input of ± 5 volts d-c. Null level is on the order of 5 mv and is mainly second harmonic. Drift stability not as good as other circuits and varies with filament voltage. For applications where extremely high vibration is present where electromechanical switch might be damaged. Extremely long life of this modulator makes it useful where low maintenance is required

DIAMOND MODULATOR—An electronic-switch type modulator utilizing the carrier signal to turn either electron tube or crystal diode on and off to modulate the d-c input signal. Produces much higher signal-to-noise ratio than most electron-tube modulators. Ratio is on the order of 1,500 to 1, with a carrier voltage of 19 v rms. The output is linear up to 3 v rms with a d-c input of ± 10 v. Reducing the filament voltage further increases the signal-to-noise ratio, but may reduce life of the diodes. This circuit has long-time drift stability of less than 1 millivolt referred to the output.

Suitable for airborne military applications where environment is severe. May be used to replace electromechanical switch modulator where extremely long life with no maintenance is required



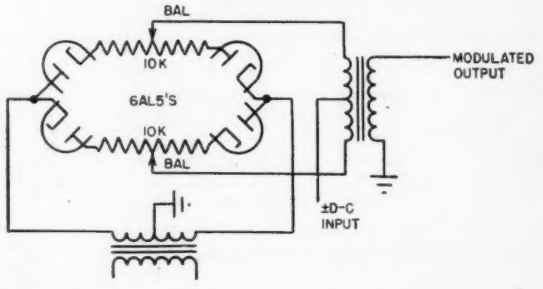


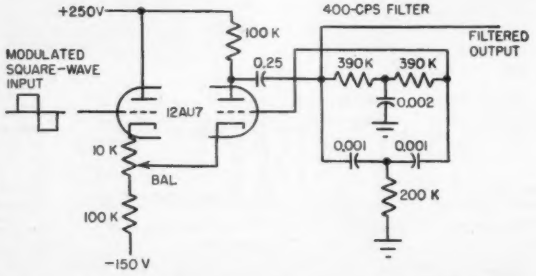
TRIODE CLAMP MODULATOR—This circuit is also of the electronic-switch family but utilizes triodes in place of diodes. Principal advantage of this circuit is that large magnitudes of input voltage swing may be tolerated and still produce a linear output. With a carrier voltage of 6.3 v rms, the output is linear to 2 v rms with a d-c input signal of ± 25 volts. The null level is high, approximately 100 mv. This can be reduced by filtering. Long-time drift stability is excellent. The output signal is normally square wave, but a tuned circuit is shown in the circuit above to get a sinusoidal signal.

This modulator is best suited for system applications where the input signal swing is unusually large.

RING MODULATOR—Circuit is shown with single-ended input and output but can be operated with either the input or the output ungrounded. Increasing the magnitude of the carrier voltage tends to increase the signal-to-noise ratio as well as the linear output swing. With a 100-v rms carrier and a d-c input of ± 30 v, the output is linear up to 0.2-v rms. Null level is less than 1 millivolt, but the drift stability is not as good as most switch-type modulators.

The circuit may be used in system applications where modulation of the error signal is required, but has poor drift stability and critical balance requirements





TWIN T 400-CPS FILTER—This circuit may be utilized with all modulators described here to increase the signal-to-noise ratio. The filter is tuned to 400 cps and therefore feeds back all other frequencies tending to eliminate them. The Q of the filter is six. The output signal is a low distortion sine wave and is in phase with the input.

The circuit is useful for applications with square-wave or switch-type modulator where a sinusoidal output signal is required. However, it is necessary that the frequency regulation of the carrier signal be 1 percent or better or the filter will introduce phase shift that may be detrimental to overall system operation

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What's inside this engineer-scientist's head? A camera won't reveal that for 30 years a trained mind has been accumulating a vast fund of knowledge on gyroscopes and has come forth with sound original thinking on inertial guidance.

No photograph can tell that another man thoroughly grasps the present state of the art in infrared technology and has creative ideas for the future.

We can't show pictorially the knowledge and reasoning ability other staff members bring to such subjects as radar, general electronics, semi-conductors, computation, mechanical design, and all the other fields of competence that go to make up a balanced research and development facility.

Nor can we show the special types of gray matter that make a first class systems engineer, a top production man, or a forward-looking executive to keep these specialists functioning smoothly as an integrated organization.

But we can tell you what these people have done in the past, what they are doing now (where military security permits), and what we believe they can do for you. Write Dept AW, Mechanical Div., General Mills, 1620 Central Ave., Minneapolis 13, Minn.

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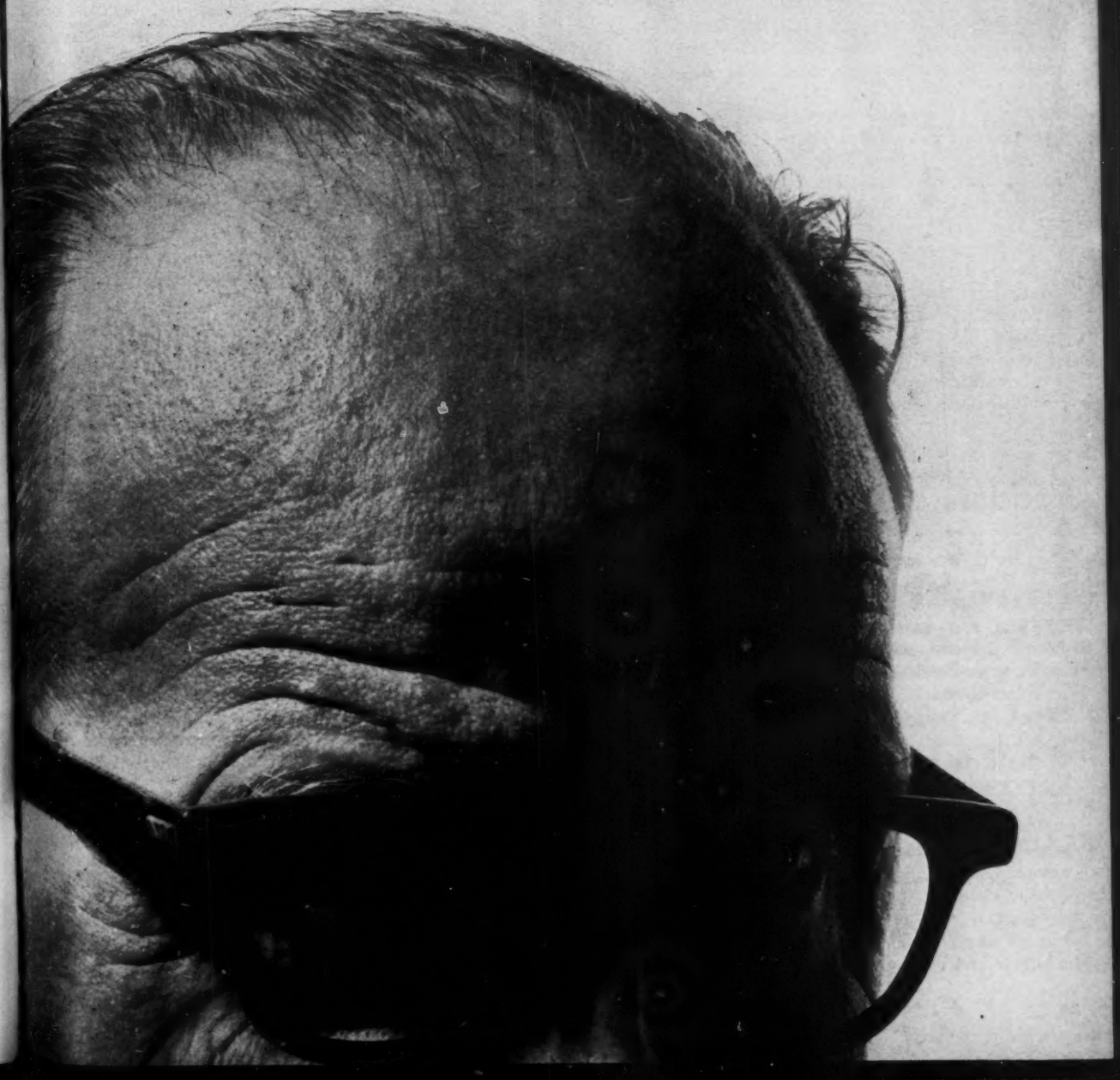
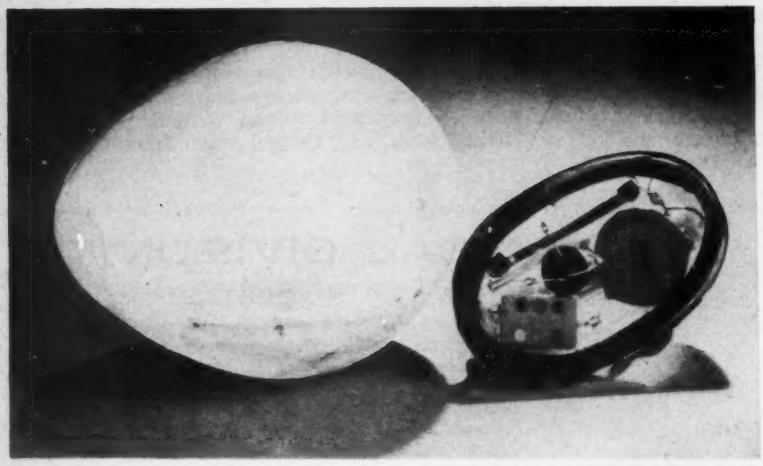


Radio Thermometer Fits in Penguin Egg



Thermistor changes oscillator frequency in proportion to temperature changes

RECENTLY developed components have made possible a radio thermometer with far-reaching possibilities. Immediate application is to monitor the temperature at which the penguin keeps its eggs.

The purpose of the penguin experiments is to look for some of the reasons that make it possible for some forms of animal life to withstand extreme cold. Other forms, anatomically similar, perish under similar conditions.

A little deception of the penguins is required. The egg is opened and its contents removed. The radio thermometer and gelatin is substituted. The egg is resealed and returned to the unsuspecting penguin.

The radio was developed by American Electronic Laboratories for the Office of Naval Research. As well as size limitations, the device had to be wireless, since penguins are inclined to carry their eggs from place to place.

Inductive pickup was used rather than conventional radiated r-f energy. The salt water or flesh surrounding the egg would tend to absorb r-f. In addition, designing an antenna that would fit in a penguin egg posed problems.

The unit uses a transistor oscillator powered by three mercury cells. It is said to operate continuously for 150 hours.

The use of a transistor was a natural. It is not only small, light and economical of power, but does not generate heat. In addition, being a current device, it is suitable for supplying current for the coil.

The radio thermometer has a range of 80 feet, is accurate to within 0.2 F and weighs only 80 grams.

Another application of the thermometer is to test the effectiveness of survival suits. First reports from the Antarctic on these tests indicate that a man swimming in water at 28.5 F increases his body temperature to 98.9 F while actively swimming for the first 12 minutes. After that, while resting, his temperature decreases at the rate of about 0.3 F every two minutes. The experiments last 20 minutes.

Other planned uses for the radio thermometer include studies of chickens and reindeer.

Transistor Drives Clock

BY C. HUNTER MCSHAN
Great Neck, N. Y.

BALANCE and hairspring assemblies of conventional clocks can be driven by self-switching transistor circuit as shown in the diagram.

The balance wheel is modified by mounting a small cylindrical magnet on its rim and poising with a counterweight. A stator of soft magnetic material with a tapped winding is positioned to receive the magnet at the instant of maximum balance velocity. Stator thickness is made equal to the diameter of the magnet. The circuit is comprised of a tapped winding, resistor, transistor and energy source. The coil-form terminals serve to mount the resistor and transistor as a complete subassembly.

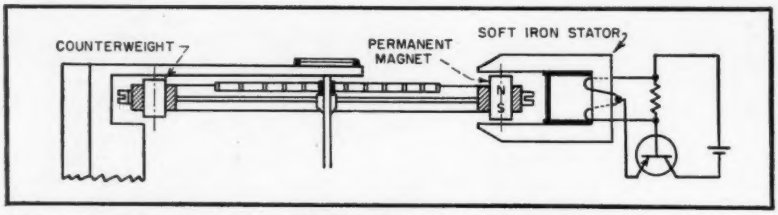


FIG. 1—Arrangement of balance wheel and transistor drive system

Operation

As the balance magnet enters the stator, the transistor remains in its normal cut-off or open circuit state. During this entry period, the attraction force of the permanent magnet acting upon the stator imparts energy to the balance. As the magnet begins to leave the stator, a signal is generated of the proper polarity to start a regenerative process of triggering the transistor to full conduction. This triggering process occurs in

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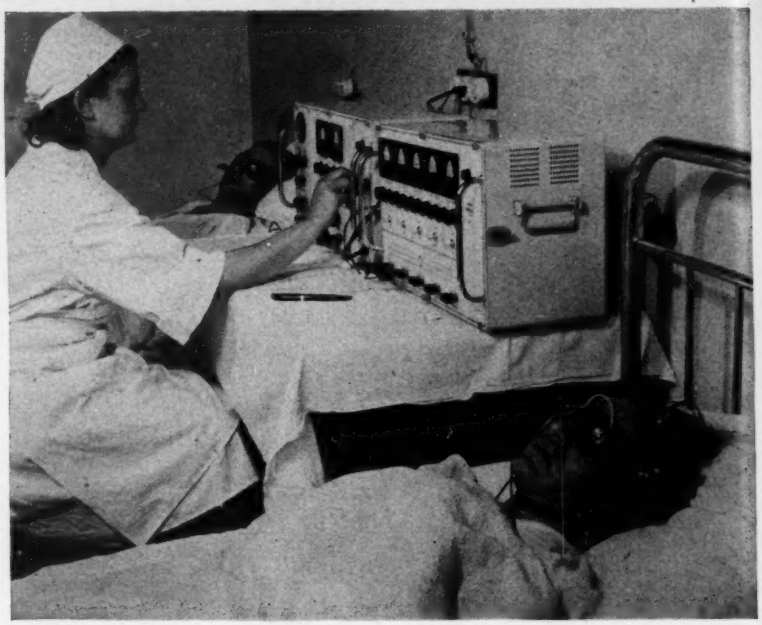
less than 0.0002 second. Flow of current through the transistor and part of the winding then produces a magnetic field which repels the balance magnet away from the stator poles. The driving forces of attraction and repulsion may be designed to deliver equal amounts of energy so that the natural balance rate is not disturbed. Deviation of the hairspring from true isochronal operation may be compensated by unbalancing these forces. The resistor critically damps the circuit to prevent self-oscillation. The stator may also operate a gear train stepping armature if it is desired to use the added precision of a free-swinging balance. The example shown uses a 1.0-gram balance 1.75 cm in diameter driven by a mechanical input of 8.0 microwatts at a 5.0000 beat rate with a total excursion of 540 deg. The Alnico V magnet measures 1.0 mm in diameter and 2.0 mm in length. Duration of the electrical impulses is 0.005 second. An initial deflection of 20 deg will start balance operation.

Pulses Cure Russian Headaches



The Russians evidently have their problems too. The electronic instrument shown was developed by the Soviets to treat insomnia, epilepsy, schizophrenia, headaches, etc. Cathodes are put on the patient's eyes and anodes on his neck. Low-voltage current pulses at one to 130 cps are passed through his head. Duration of the current varies from 0.3 to 1.4 milliseconds

Reverse-Current Tester Speeds Diode Checks

By I. J. LEVY

U. S. Naval Research Laboratory
Washington, D. C.

DIGITAL computers often use large numbers of semiconductor diodes. For example, the Naval Research Laboratory's NAREC uses 30,000 germanium diodes. Therefore, a rapid means of measuring diode reverse current at a specified back voltage has been devised.

The NAREC signal level varies between +30 and −20 volts. Therefore 50 volts was chosen for making the leakage current measurements.

A means of making reverse current measurements is to apply a back voltage across the diode and connect on ammeter in series with it. Unfortunately, this technique is objectionable. If the diode is inserted incorrectly or is shorted, the meter or the diode can be destroyed. Also a low-impedance source of 50 volts is a shock hazard. A circuit that overcomes these objections is shown in Fig. 1.

If diode D is chosen to have a negligible reverse current at 50 volts, the ammeter will always indicate reverse current through the diode being tested. Let I_{af} be the full-scale reading of the ammeter, and choose resistor R so that R = 100 volts/I_{af}.

When I_{af} is exceeded, diode D will stop conducting in the forward direction and the voltage at point A will fall below 50 volts. The maximum possible current, I_{am}, through the ammeter is 150 volts/R.

A reverse current criterion of 0.3

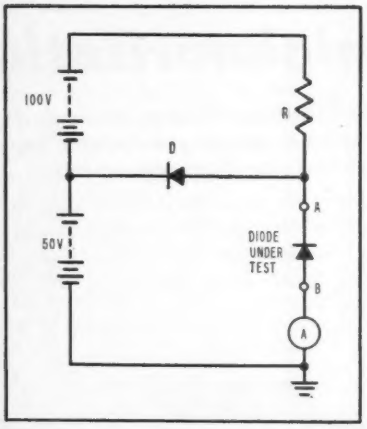


FIG. 1—Circuit protects meter since maximum current through meter is only 1.5 ma even with diode shorted

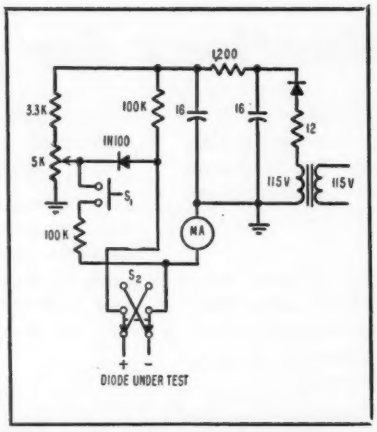
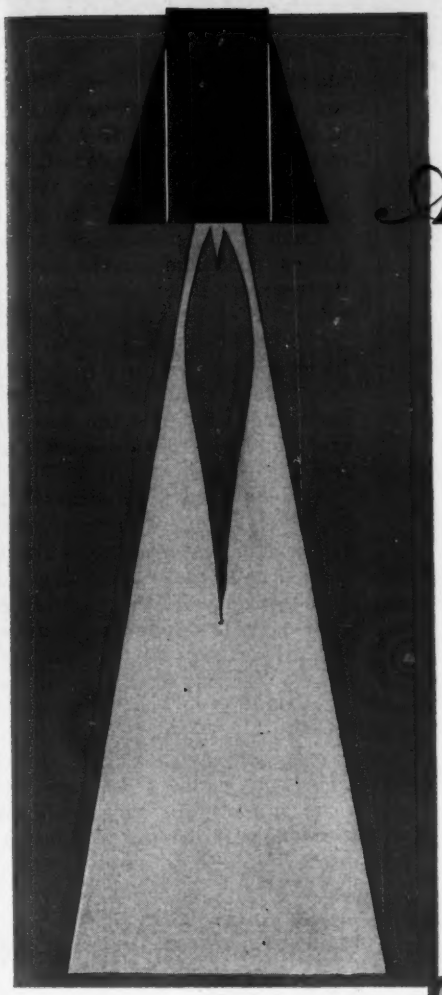


FIG. 2—Switch S_1 converts ammeter to voltmeter so that variable resistor can be used to adjust voltage at test terminals



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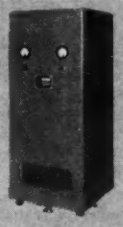
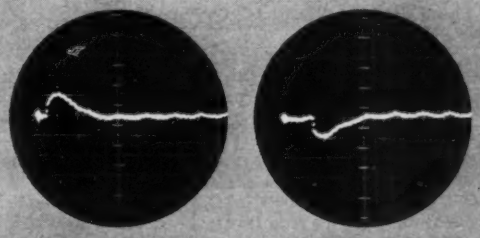
ENGINEERING BEYOND THE EXPECTED

DESIGN—When time dictates, available equipment can be adapted to your specifications. But you receive custom design, *beyond the expected,* when you need it. For example, the transistorized MAGAMP power supply (right). This unit provides a faster response time... a lower overshoot and undershoot... and remote regulation at longer distances than has ever been achieved before with this type of power supply.

DELIVERY—A contract from Douglas Aircraft for "Thor" test equipment was awarded in March 1956. A total of 100 units, comprising 30 different units, was delivered before deadline in November. On-time delivery at its best... delivery *beyond the expected.*



This transistorized MAGAMP power supply delivers a 27V to 42V output at 0 to 300 amperes, *regulated at a load up to several hundred feet away.*



The MAGAMP has a surge capacity of 400% overload for 2 seconds. Regulation at the load is 1% or better. Recovery time is less than 50 milliseconds. Overshoot and undershoot are less than 25%, with a 30% change in load. (Scale in above photos: 5V/CM and 10MS/CM.)

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ma at a reverse voltage of 50 volts was chosen for the germanium diodes used in the NAREC. An ammeter with a full-scale deflection of 1 ma and a resistance of 100,000 ohms for R were selected. With this value of R under short-circuit conditions, maximum current through the ammeter is 1.5 ma. Also, this value of R allows the voltage across the diode under test to be 50 volts for all currents less than 1 ma. With this arrangement the meter, the diode under test and the operator are protected from excessive current.

A more versatile instrument is shown in Fig. 2. This instrument has several features that make it convenient to use. Switch S_1 when depressed converts the meter from an ammeter to a voltmeter, to measure the voltage at the test terminals. Variable resistor R_2 is used to adjust this voltage to the desired value (half-scale reading on meter). Switch S_2 reverses the diode connections and permits checking the diode in both directions without removing it from the test instrument.

Transistor Radio Uses Few Parts

By S. A. SULLIVAN

Sonoma, Calif.

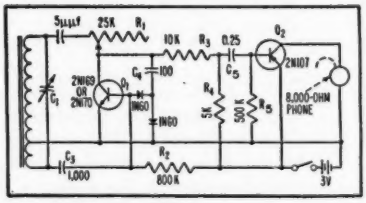


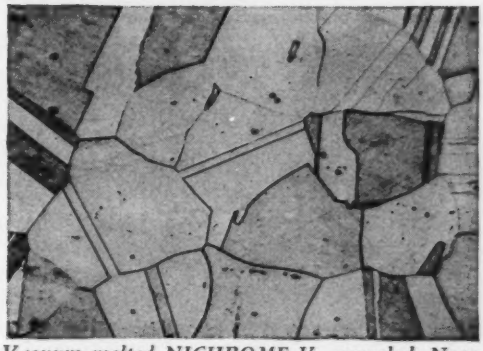
FIG. 1—Transistor Q_1 is used regeneratively as an r-f amplifier and reflexively as the first a-f amplifier while Q_2 functions as the power amplifier

SENSITIVITY and selectivity are said to be quite good for a transistor radio that uses a minimum of parts. The circuit is a descendant of the reflex-type of the early twenties.

In Fig. 1, r-f energy applied to the base of Q_1 through C_3 is amplified and coupled to the diodes through C_4. Resistor R_3 acts as an r-f choke. The audio output of the diodes is applied directly back to

4 Improvements in NICKEL-CHROME ALLOYS Now Obtainable from Driver-Harris Vacuum Melting Service

Polished and etched sample of Air Melted NICHROME V in annealed condition.*



Vacuum melted NICHROME V, annealed. Note that reduced inclusions result in much larger grain size for the same annealing treatment.

After many years of experience with vacuum melting programs, Driver-Harris now offers a complete vacuum melting service for almost all of the 132 special purpose alloys made by this company.

The specific benefits gained by vacuum melting in the production of nickel-chrome alloys are today clearly established. They are:

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3. Complete elimination of gas, not from the surface only but from the entire mass. Alloys so produced are therefore more desirable in the manufacture of electron tubes.

4. General improvement in electronic, electrical, and mechanical properties to meet specifications. Because closer control of analysis is a primary advantage of vacuum melting, we can now achieve these specific improvements with remarkable certainty.

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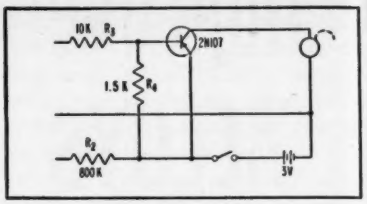

FIG. 2—Alternate output stage eliminates C_5 and R_5 but R_2 and R_4 must be determined by trial and error

the base of Q_1, which now functions as the first audio amplifier. The amplified audio is coupled to the output stage by C_5. Regeneration through C_2 is controlled by R_1. An 800,000-ohm resistor is nominally selected for R_2, but the correct value must be chosen empirically.

Performance can be improved even further by replacing R_5 and R_4 with r-f and audio chokes, but size and cost will be increased.

Using the direct-coupled alternate output circuit shown in Fig. 2, C_5 and R_5 can be eliminated. However, R_2 and R_4 become interdependent and require more juggling to determine optimum values. In addition some loss of output is experienced because of the shunting effect of R_4 on the input of Q_2. Occasionally a transistor will be found for Q_2 the characteristics of which also allow R_4 to be eliminated.

Tv Receivers Substitute for Marine Radar

By Carla Baroccio
Rome, Italy

Radar's benefits at tv receiver prices is a bargain being given to some Italian vessels. Even radar-equipped ships are given an added margin of safety by the system.

A radar system is set up at an appropriate spot in the harbor so that the antenna can scan the area. The presentation on the radar receiver screen is picked up by a tv camera. The video is then broadcast from a hill on the nearby shore.

Vessels equipped with a relatively inexpensive tv receiver are given a continuous radar map of the harbor. The high-grade picture is said to be better than that sup-

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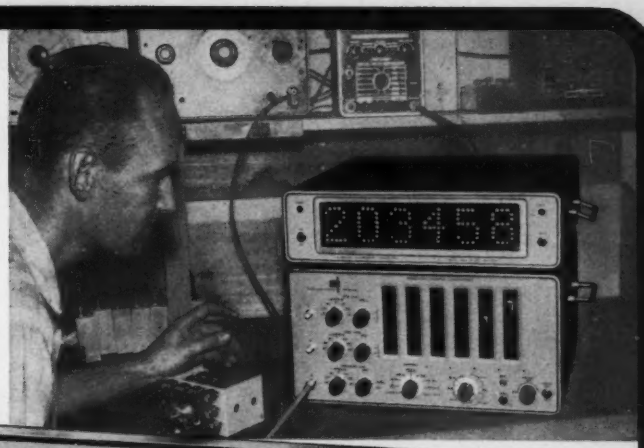

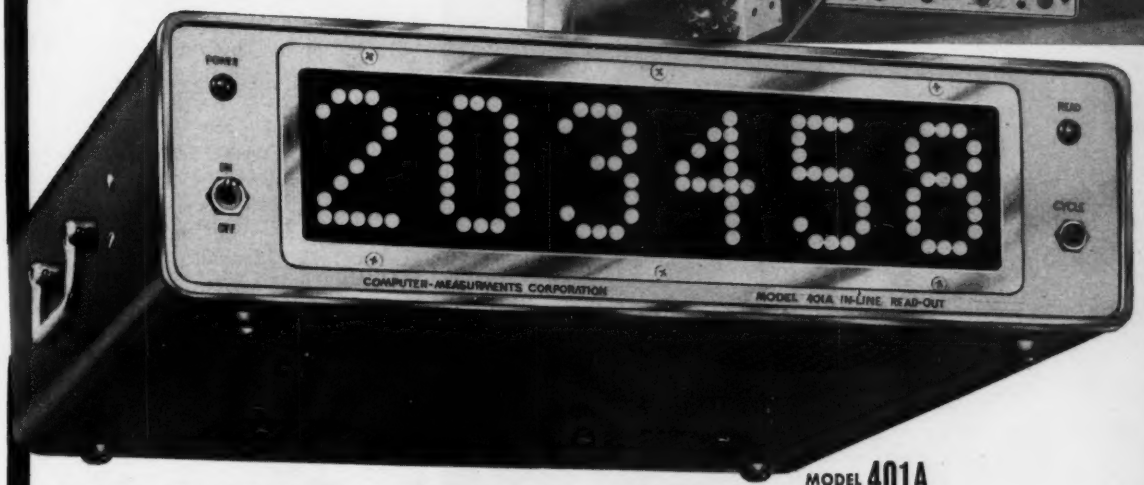

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SPECIFICATIONS

Indicating Capacity	6 Digits
Accuracy	Identical to counting instrument.
Signal Input Requirements	4-line 1-2-2-4 binary decimal code and read command from counting instrument for automatic operation.
Power Requirements	117 V ± 10%, or 230 V ±10%, 50-60 cps, 125 watts
Dimensions	17" W x 4½" H x 17½" D approximately.
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plied by some low-power radars. Even ships with good radar find it helpful to compare their presentation with that on the tv receiver.

Cathode-Follower Gain Approaches Unity

DESIGNERS frequently must couple a high-impedance source to a low-impedance output without attenuating or loading the source signal. This could be done using a cathode follower with unity gain and low output impedance.

Such a circuit has been devised and is shown in Fig. 1. It has a gain of 0.99963, an output impedance of 50 ohms and a response within 3 db from d-c to 250 kc. The circuit delivers outputs from −140 to 210 volts at −0.8 to 2.0 ma.

The input signal is applied to the control grid of the pentode, V_1. The

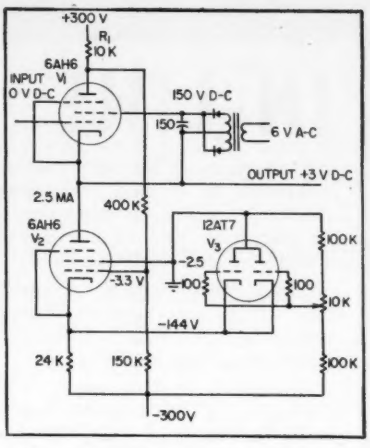

FIG. 1—Feedback through pentode helps maintain unity gain

cathode follows as in a conventional cathode follower. Any departure from unity gain appears as a voltage between the cathode and the grid. This voltage in turn affects plate current and appears as an amplified voltage across plate resistor R_1. This voltage is coupled to the control grid of pentode V_2 and is again amplified appearing at the plate of V_2 in phase with the output at the cathode of V_1. This negative feedback cancels most of the de-

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BV_{EBO} (I_E = 250 μA)	8	8	V
BV_{CEO} (I_C = 250 μA)	60	100	V
BV_{CBO} (I_C = 100 μA)	60	100	V

design characteristics @ 25°C (case temperature)

	min.	des. cen.	max.	unit
R_{CS} (I_B = 40 mA; I_C = 200 mA)	—	20	40	Ohm
h_{FE} (V_C = 10 V; I_C = 200 mA)	12	20	36	—

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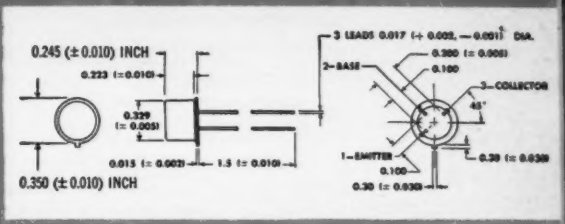

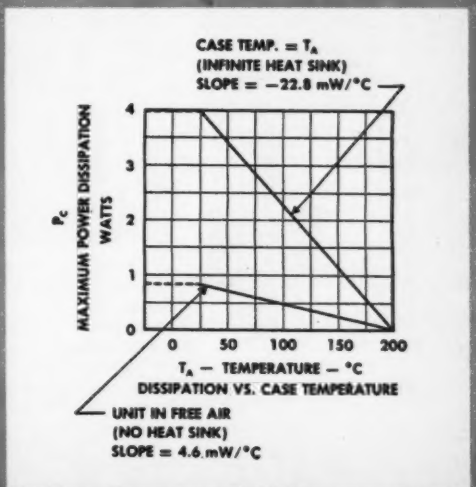

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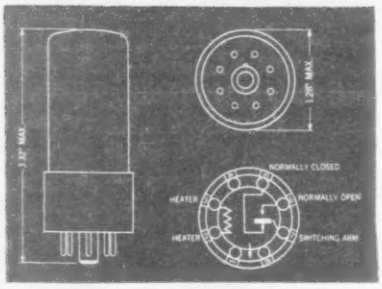
Tung-Sol produces a line of thermal relays in the general operating range characterized by the Type 609. Snap action contacts and extremely sensitive actuating heater elements provide uniform cycling. Operating principle permits manufacture of time delay relays and relays which function on small differential of voltage and current. Compact and lightweight, Tung-Sol relays are ideal for instruments and electrical equipment application.

NOMINAL DESIGN CONSIDERATIONS

Contact capacity.....1 amp 30 volt resistive
Contact arrangement.....SPST (NC) or SPDT
Operating power.....As low as ½ watt
Time delays.....Up to 5 seconds
Operate on current differential as small as .05 amps
Operate on voltage differential as small as .3 volts



NOMINAL CHARACTERISTICS OF 609

Operating voltage.....6.4 volts
Operating time.....1. plus or minus .5 seconds
Release time.....1. plus or minus .5 seconds
Contact capacity.....1 amp at 30 volts
Contact arrangement.....SPDT

For additional data write:
Electroswitch Division, Tung-Sol Electric Inc., Newark 4, N. J.

Sales Offices: Atlanta, Ga.; Columbus, Ohio; Culver City, Calif.; Dallas, Tex.; Denver, Colo.; Detroit, Mich.; Irvington, N. J.; Melrose Park, Ill.; Newark, N. J.; Philadelphia, Pa.; Seattle, Wash. Canada: Montreal, P. Q.

TUNG-SOL® THERMAL RELAYS

parture from unity gain. The feedback action also produces the low output impedance of the circuit.

A pentode was chosen as the input tube because of its constant plate current with varying plate voltage. An isolated screen supply producing no current in the cathode return was required to retain this characteristic. A pentode was used as the cathode return, because it has high mutual conductance and high impedance. A cathode follower V_3 rather than a glow tube was used to supply −144 volts at low impedance to the cathode of V_2 because it uses less plate current and has continuous characteristics.

A bias cell or mercury battery may be used in series with the input if the d-c output voltage level is to be the same as that of the input.

This circuit is actually a d-c version of an earlier circuit[1] by Hammack having only a-c response. His mathematical analysis is valid for this circuit also.

Reference

(1) C. M. Hammack, Cathode Follower of Very Low Output Resistance, Electronics, p 206, Nov. 1946.

A-C Threshold Converts to Switch

By William E. Earle
Earle & Blake, Inc.
Brockton, Mass.

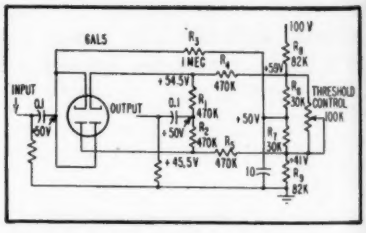


FIG. 1—With control set for maximum resistance, peaks of a-c voltage above 4.5 volts are passed by diodes

Background noise can be eliminated from audio signals without affecting a-c balance of the signals with a balanced variable threshold circuit. Substituting a triode tube for the threshold control potentiometer converts the circuit to an electronic switch that is free of tran-

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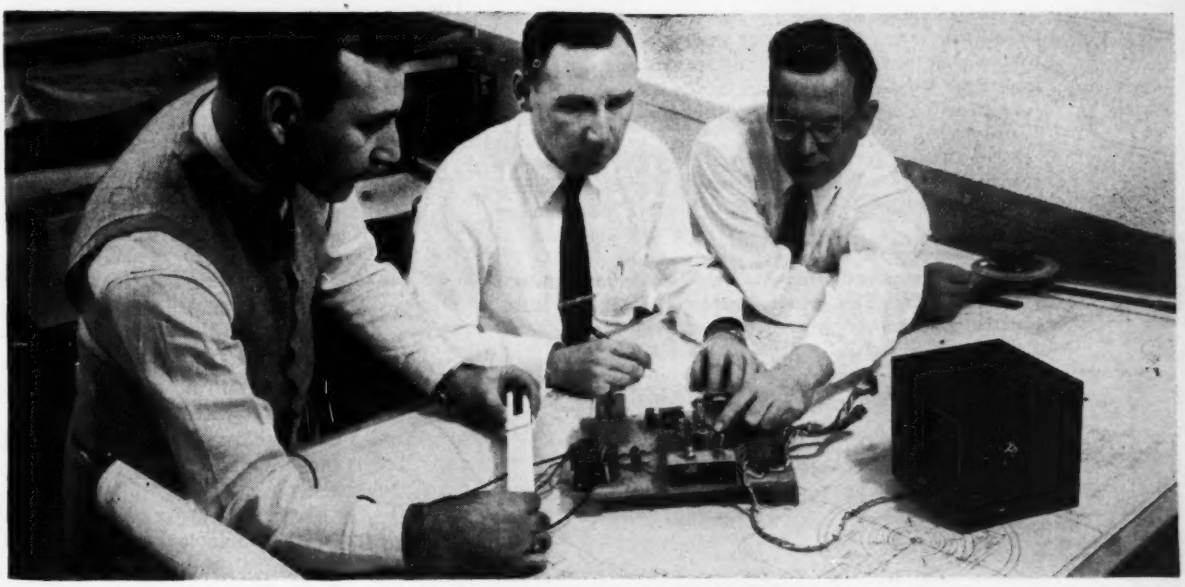

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Bristol's Syncroverter† chopper is now available in a low-noise, external-coil model for critical dry circuit applications.

This new external-coil chopper virtually eliminates capacitive coupling between signal-circuit contacts and driving coil leads. Peak-to-peak noise levels are usually *less than 100 microvolts* across a 1 megohm impedance (rms noise, in the order of 10 microvolts).

LONG LIFE and immunity to severe shock and vibration are outstanding characteristics of the new Syncroverter chopper. Withstands vibration, 5 to 2000 cps, up to 30G, and up to five 30G impacts on any major axis. SPDT switch action. Nominal contact ratings: up to 10 V, 1 ma.

Write for complete data on this latest addition to the Bristol Syncroverter line. The Bristol Company, 152 Bristol Road, Waterbury 20, Conn. 7.31

†T. M. Reg. U. S. Pat. Off.

TYPICAL CHARACTERISTICS

Driving Frequency Range:	0—1800 cps
Coil Voltage:	6.3 V sine, square, pulse wave
*Coil Current:	70 milliamperes
Coil Resistance:	52 ohms
*Phase Lag:	60° ± 10°
*Dissymmetry:	15° max.
*Switching Time:	15° ± 5°
Temperature Ranges:	−55°C to 100°C or −65°C to 125°C
Operating Position:	Any
Mounting:	Flange; 2-hole or 4-hole Plug-in; fits 7-pin miniature socket

*These characteristics based on sine-wave excitation, 400 cps.

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sients and can handle large input signals. Characteristics of the tube have no effect on circuit balance.

The variable threshold circuit is shown in Fig. 1 with no signal applied. When threshold level is set at maximum, circuit voltages will be as shown.

Since both diodes are cut off by a 4.5-volt reverse bias, a signal applied at the input will not pass through the diodes unless its amplitude exceeds 4.5 volts. For larger input signals, the voltage in excess of 4.5 volts will appear at the output terminal after passing through series resistors R_1 and R_2. If a sinusoidal signal of 18 volts peak-to-peak is applied to the input terminal, the output waveform will be that shown in Fig. 2A.

As threshold-control resistance is decreased, biasing voltages on the diodes will decrease allowing more of the input signal to appear at the output. With no resistance, the entire input waveform will appear at the output as shown in Fig. 2B.

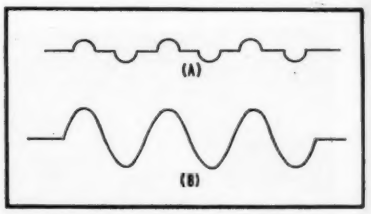

FIG. 2—Noise can be eliminated from audio-frequency a-c without affecting a-c balance

Electronic Switch

By substituting a vacuum tube for the variable resistance threshold control, the circuit becomes an electronic switch.

With V_2 in Fig. 3 at cut off, the threshold will be at its highest value. This corresponds to the off position of the switch. With V_2 conducting, the resistance between points A and B will be low and only a small threshold will exist. Resistors R_1 and R_2 eliminate the remaining threshold allowing all signals to appear unclipped at the output. Hence, with V_2 conducting the switch is in its on position.

Because the signals pass through the high series resistances R_1 and

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new vinyl plastic tape for total adhesion

In spite of technological advances in electricity and electronics that stagger the imagination, the past few decades have seen little progress in the science of insulating tape manufacture. The electrical tapes of today have been, until now, substantially the same as they were in 1920 . . . and some of them are pretty good, no question about it.

In the 1940's, however, there was one break; spurred by the needs of modern electronics, *plastic* tapes — polyvinyl chloride sheetings, plasticized and adhesive coated — came into limited use. Since then, again, plastic tapes have improved but slowly.

Now, in 1958, Plymouth Rubber Company, Inc., manufacturer of quality rubber and plastic products since 1896, has at last broken the vinyl tape barrier. After years of laboratory research and months of testing in the field under the most extreme conditions, SLIPKNOT #7 PLASTIC ELECTRICAL TAPE is ready for use.

Here at last is a *vinyl* tape you *know* you can depend on. ZF-90* inseparably fuses adhesive to vinyl base; they *cannot come apart*, and therefore *will not dry out*. This is *total adhesion*, making splicing easier, swifter, surer than ever before. New Slipknot #7 has a wider temperature working range, too, than other plastic tapes.

There has been a great need, also, for a method of cutting plastic tape easily, and eliminating the waste caused by stretching and thinning the next several inches on the roll.

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PHYSICAL PROPERTIES		ELECTRICAL PROPERTIES	
Thickness	.007" ± .001"	Dielectric Strength ASTM Method	10,000 volts minimum
Tensile Strength	25 lbs./ inch width	Power Factor at 60 Cycles	.07
Elongation At Break	150% minimum	Power Factor at 10^6 Cycles	.03
Adhesion to Highly Polished Surface	30 oz./ inch width	Dielectric Constant at 60 Cycles	3.2
Adhesion to Backing	28 oz./ inch width	Dielectric Constant at 10^6 Cycles	2.3
Transfer of Adhesive	None	Insulation Resistance	500,000 Megohms
Moisture Vapor Transmission	2.5 gms./ 100 sq. in/ 24 hours	Electrolytic Corrosion Factor	1.0

Data given represents averages and should not be taken as maximum or minimum for specification purposes.

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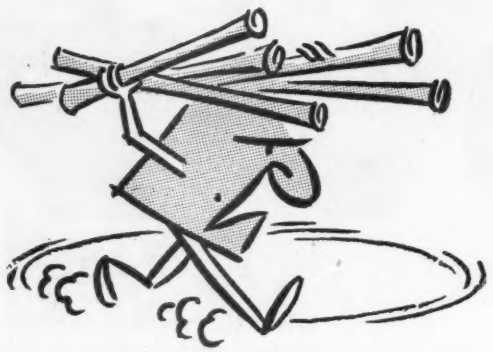

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R_9, high-frequency response is limited. However, the nontransient properties of the switch and its ability to handle large input signals

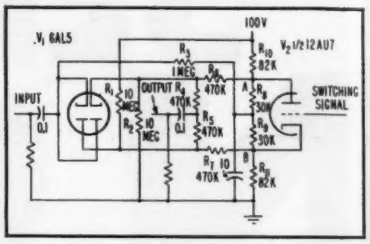

FIG. 3—Output when switch is closed is not dependent on tube characteristics

more than compensates this limitation. By exactly matching resistors R_1 and R_2, R_4 and R_5, R_6 and R_7, R_8 and R_9 and R_{10} and R_{11}, switching transients are completely eliminated if no grid current is allowed to flow in the control tube. Tube characteristics have no effect upon circuit balance.

The electronic switch may have applications in commuting circuits where stable, nontransient switching, free from the effects of changing tube characteristics, is essential.

Regulated Supply Offsets Line Changes

By LOUIS COSTRELL

Radiation Physics Laboratory
National Bureau of Standards
Washington, D. C.

SOME CIRCUITS are affected by changes in line voltage even though the B+ is well-regulated. This can result from unregulated filament voltage or use of unregulated B+ in some parts of the circuit. The change in line voltage can sometimes be compensated in circuits with essentially constant load by using a compensating-type regulated supply. The supply changes voltage in a direction opposite to that of the unregulated voltage.

A conventional regulated power supply can be made to do this by the addition of two resistors and a capacitor (R_2, R_4 and C in Fig. 1). The compensating factor $-(\delta V_2/$

δV_1) can be controlled over a considerable range from zero to values greater than unity.

From Fig. 1B:

$$I_1(R_3 + R_4) + I_2R_3 = V_1$$
$$I_1R_3 + I_2(R_1 + R_2 + R_3) = V_2$$
$$I_1R_3 + I_2(R_2 + R_3) = V_{ref}$$

From which is obtained:

$$V_2 = \frac{V_{ref}(R_1R_3 + R_3R_3 + R_1R_4 + R_2R_4 + R_3R_4) - V_1R_1R_3}{R_2R_3 + R_2R_4 + R_3R_4} \quad (1)$$

$$\frac{\delta V_2}{\delta V_1} = -\frac{R_1R_3}{R_2R_3 + R_2R_4 + R_3R_4} \quad (2)$$

$$R_1 = \frac{(V_2 - V_{ref})(R_2R_3 + R_2R_4 + R_3R_4)}{V_{ref}(R_3 + R_4) - V_1R_3} \quad (3)$$

Since noise and ripple are presumably present in the unregulated

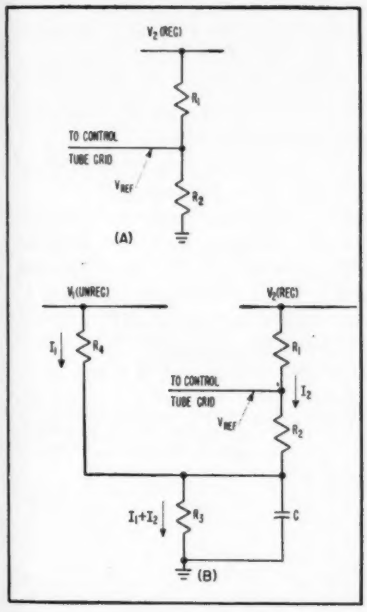

FIG. 1—Addition of R_3, R_4 and C enable regulated supply to compensate changes in line voltage

voltage (V_1), capacitor C is added to limit the transfer of this noise and ripple to the regulated output (V_2). The capacitor should be large enough so that the output impedance is low at the lowest frequency of interest. If the capacitor has appreciable inductance, as is often the case with electrolytics, it is well to shunt it with a small paper, mica or ceramic capacitor.

With elimination of terms as the sole objective, R_4 can usually be made equal to R_2. Table 1 shows the compensating factors obtained with a typical circuit for various

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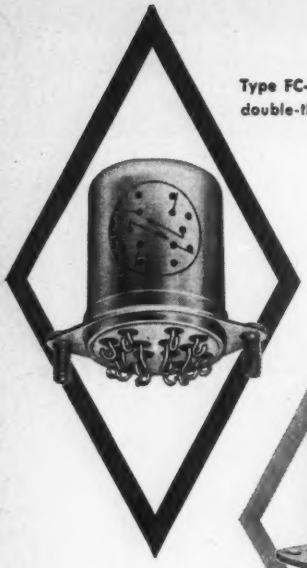

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Table I—Compensating Factors for Typical Circuit

R_3 (in thousands)	R_1 (in thousands)	$-\delta V_2/\delta V_1$
0	200	0
1	210	0.026
2	221	0.042
5	259	0.118
7	289	0.178
10	343	0.286
15	473	0.545
20	700	1.000

$V_1 = 400$ volts
$V_2 = 300$ volts
$V_{ref} = 100$ volts
$R_2 = R_4 = 100{,}000$ ohms

values of R_3. Resistor R_1 is chosen so that $V_2 = 300$ v when $V_1 = 400$ v. It will be noted that with $R_3 = 20{,}000$ ohms, $\delta V_2/\delta V_1 = -1$, so that the percentage change of V_2 is equal and opposite to that of V_1.

An example of the application of this circuit is provided by a high-gain, wide-band, linear amplifier in which constant gain is desired. This requires a 0.1-percent increase in B+ for a 1.0-percent decrease in line voltage so that $\delta V_2/\delta V_1 = -0.1$. Since for this amplifier $V_1 = 450$ v, $V_2 = 285$ v, $V_{ref} = 105$ v and $R_2 = 200{,}000$ ohms, compensation was obtained with $R_1 = 449{,}000$ ohms, $R_3 = 9{,}800$ ohms and $R_4 = 200{,}000$ ohms.

Of course, complete compensation is obtained only if the required compensating factor is constant over the range of line voltage for which compensation is desired. Though this ideal situation cannot be realized, a high degree of compensation is obtained.

Circular Nomograph for Percent Change

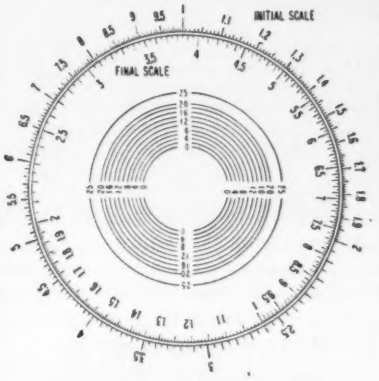
By Gary Lynn Schwendiman
Quality Control Engineering Department
Raytheon Manufacturing Company
Newton, Mass.

Clerical workers are said to learn quickly to use a percentage-of-change nomograph. It was developed to compute percentage of change in characteristics of tubes when test conditions are changed or over a period of time.

Such percentages are easy to

compute by simple arithmetic, with more conventional square-shaped nomographs or by slide rule. However, if hundreds of items are read daily and a percentage must be computed for each, this nomograph has been found to save much time. It is faster than a calculator and faster and easier to teach clerical personnel than a slide rule.

The use of a logarithmic scale on a circular form makes it usable no matter what the range or magnitude of the figures, since the scale is without beginning or end. Also, the circular form makes it possible to present scales on standard 8½ by 11-inch paper. To get equivalent

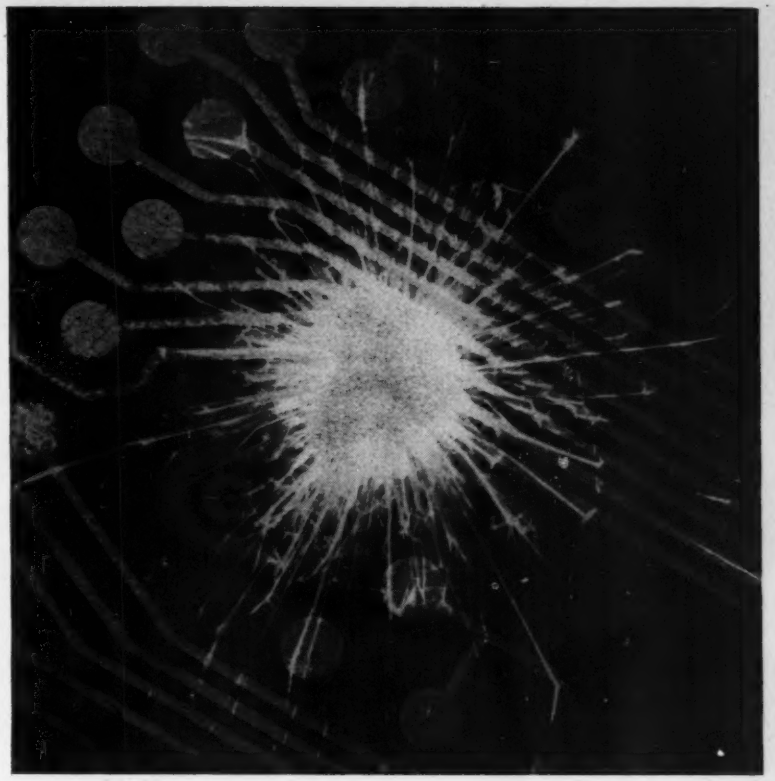


Percent change nomograph simplifies production-line computing

precision on a standard three-line alignment chart would require that it be 30 inches long.

The graph consists of two concentric circular logarithmic scales, one on the outside and one on the inside of a circle. The inner scale is displaced clockwise 150 degrees. A series of smaller concentric circles represent differences expressed as percentages.

To use the nomograph, the operator places a straight edge at the initial reading on the outer scale and on the subsequent reading on the inner scale. The straight edge will fall tangent to the smaller circle that represents the percentage of change. In its present form it is only usable when the initial reading is greater than the final one and when the decrease is 25 percent or less. However, the design can easily be modified for other applications.



Uniformity of Taylor Rolled Copper-Clad Laminates helps prevent shorts in printed electronic circuits

Taylor Rolled Copper-Clad Laminates help prevent both shorts and open circuits: shorts because the copper is free of lead inclusions; open circuits because the metal is free of pits and pinholes. They have such high uniformity that even lines only 0.002 in. wide, and only 0.004 in. apart, can be produced. These features also help prevent resistance buildup and other faults that cause failures in radios, television sets, and other electronic devices in home and industry.

Production control at Taylor Fibre Co. is responsible for this highly uniform printed circuit material. Taylor has devised a unique method of bonding high-purity rolled copper to the base laminate—and keeping it securely bonded even under severe conditions of temperature, humidity and mechanical stresses. From this results the production of printed circuits of consistently high quality.

Actual size of printed circuit on Taylor Copper-Clad Laminate. The lines are only 0.002 in. wide and only 0.004 in. apart.

This is only one of the many Taylor Fibre Co. products that are meeting industry's demands for improved materials with superior performance characteristics. If you require laminated plastics—in basic form or fabricated parts—contact the nearest Taylor sales office. Save time and money with the right source of supply.

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TAYLOR FIBRE CO. Plants in Norristown, Pa., and La Verne, Calif.

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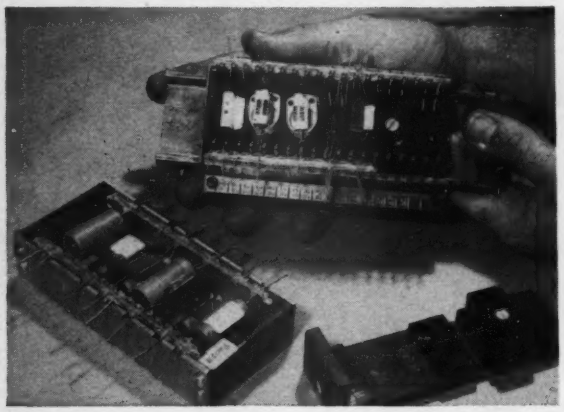
Spacing Jigs Hold Capacitors for Ladder Networks



Metal ladder jig at top center is used with various plastic spacing jigs like that at lower right to give correct positioning of components. Metal pins for leads are identified by punched letters on cutside strip. Inspection jig at left shows out-of-place leads at a glance

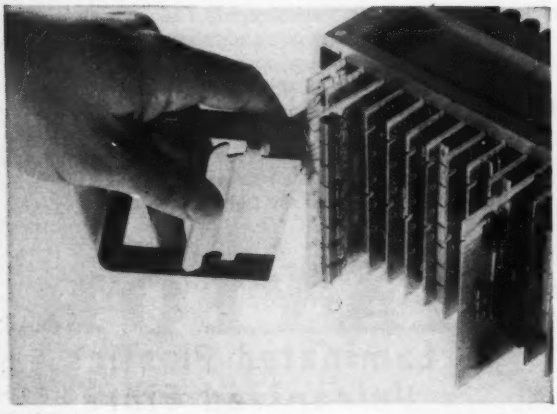
Spacer in left hand slides into position between pins of jig in right hand. On bench are five other spacing jigs, one finished ladder assembly and three different inspection fixtures for checking lead positions in finished assemblies. Flexibility cuts cost of short runs

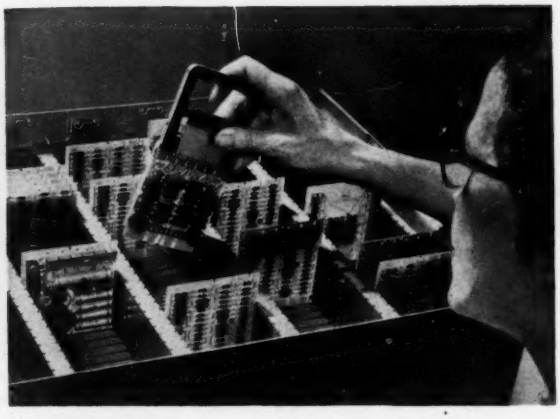
NEW TYPES OF JIGS now speed assembly of ladder-shaped stacks of capacitors for series and parallel resonant circuits at Lenkurt Electric Co., San Carlos, Calif. Capacitors of various values are stacked together to become parts of different filter networks for carrier and microwave telecommunications equipment.

Leads are secured in plastic strips, forming miniature ladders with the capacitors as crosspieces and strips as sidepieces. This is done in universal laddering jigs marked with coded lead positions to guide workers in fixing the leads to the strips.

Because of the varied sizes and shapes of the capacitors used, properly spacing them while securing the leads has been a problem. Now provided are spacing jigs for each type of ladder, shaped to fit

DESIGN TRENDS: Computer Circuit Board Handle



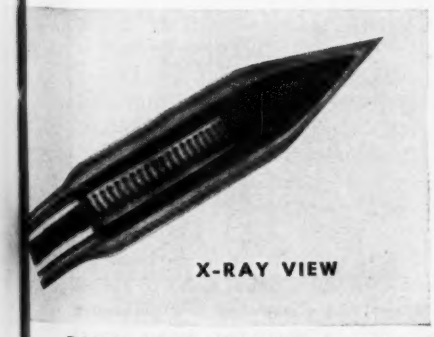


Removable handle for printed circuit boards used in computers avoids added weight and extra space taken up by fixed handles. Boards are difficult to remove without handle. Handles are designed by Ramo-Wooldridge Corp., Los Angeles, and made of paper-base phenolic laminate. Handle frame carries aluminum gripper with steel spring. Four spring-loaded pins drop into four prepunched holes on edge of printed circuit board. In designing handle for RW-30 digital airborne computer, guide pin was included in center. Test connector serves as guide on boards used in RW-300 digital control computer and in subsequent Ramo-Wooldridge computers. Photo at left shows handle being placed in gripping position. At right, circuit is withdrawn.

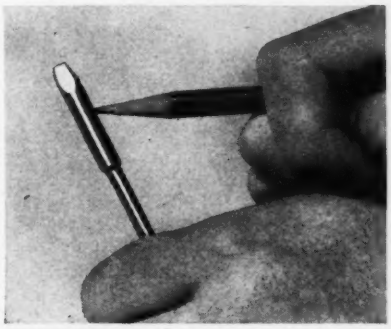
AT WORK ON THE MG-4 Fire Control System at the Autonetics Division of North American Aviation, Inc., at Downey, California, the General Electric Midget soldering iron has a man-sized job to do. In delicate assemblies like this, the Midget makes soldering easier because of its maneuverable, light-weight design and excellent heat control. Interchangeable tips, let operator tailor soldering to suit each job.

DEPENDABLE G-E MIDGET IRON cuts costs of producing MG-4 Fire Control Systems by reaching through maze of resistors, small wires, and tiny tubes quickly, easily, efficiently. . .reducing risk of damage to adjacent parts. Finished assembly, above, is one of the MG-4 System components used on North American F-86K Sabre Jets. It helps the pilot find aggressor aircraft.

Autonetics Cuts Sabre Jet Costs With General Electric Midget Soldering Irons



RAPID HEAT TRANSFER is achieved through a tubular heater located in ironclad copper tip. Result: the General Electric Midget's heat efficiency is 90%.



IRONCLAD TIP needs no filing. And by actual production-line test, a General Electric Midget iron lasts up to ten times longer than an ordinary iron.

NOW, GENERAL ELECTRIC offers this new miniature iron . . . even smaller than the popular Midget . . . for rapid soldering of critical joints in congested areas . . . provides fast, efficient heat through a tubular heater in its tip . . . weighs less than 1½ ounces, cuts operator fatigue, improves efficiency.

For more information write for GED-3553, G-E Midget Soldering Iron, Section 724-7, General Electric Company, Schenectady 5, N. Y.

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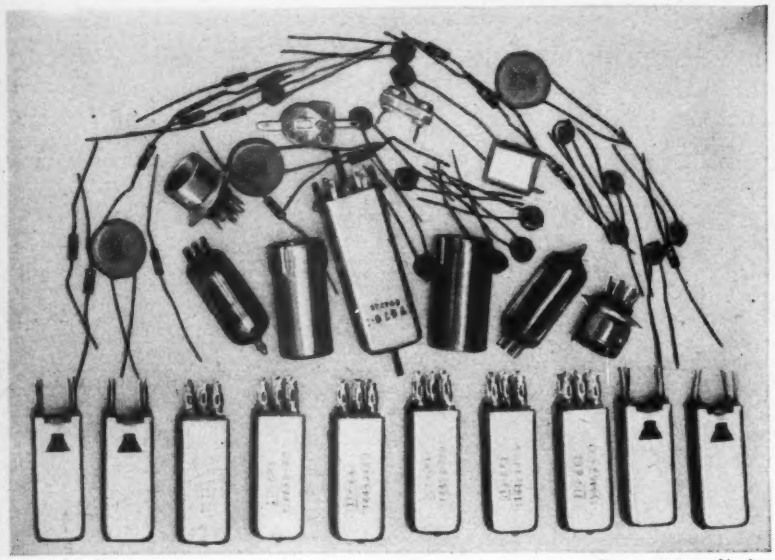
MEMO
TO *Designers of Electronic Equipment*

NOW YOU CAN REPLACE ALL OF THESE COMPONENTS



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AND REDUCE WEIGHT, SAVE SPACE,
IMPROVE PERFORMANCE AND RELIABILITY

It will pay you to investigate how this unique component can improve performance and reduce costs of your communications equipment. Hycon Crystal Filters make possible single conversions in AM and FM receivers while retaining the important advantages of double and triple conversions. These units permit excellent reception in the presence of strong jamming or interfering signals. Center frequencies are accurate to .001%. Insertion loss is 1/10 of other filtering methods. Aircraft and guided missile environmental requirements are exceeded. Write for Crystal Filter Bulletin.

HYCON EASTERN, INC.
75 Cambridge Parkway Dept. A, Cambridge 42, Mass.
Affiliated with HYCON MFG. COMPANY, Pasadena, California

into the univeral laddering jigs and properly position each capacitor. Individual inspection jigs for each type of ladder add certainty in checking proper lead placement by showing misplaced leads at a glance. Misplaced leads will not slip into the notches in the inspection jigs.

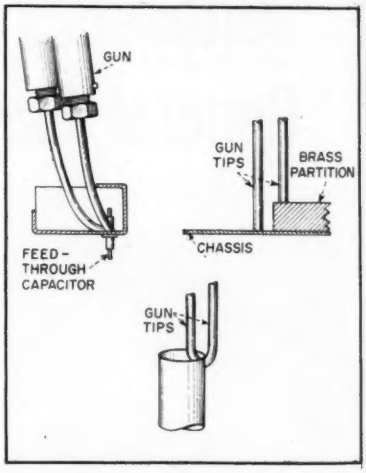
Soldering Gun Uses Chassis Resistance

By JOSEPH TARTAS

Federal Telecommunication Laboratories
A Division of
International Telephone and Telegraph Corp.
Nutley, N. J.

HEAVY-DUTY SOLDERING guns will produce large amounts of heat almost instantaneously in a small, normally inaccessible area when adapted to use the chassis as part of the path for heating current.

The technique was developed so that feed-through capacitors could be soldered into a miniature chassis having thin brass internal shield partitions. Excessive heat



Copper tips of soldering gun are shaped to make good contact with capacitor flange, partition or tube seam

was banned since the partitions were soft-soldered. Torches, soldering irons and soldering guns as normally used proved unsatisfactory, even with special tips.

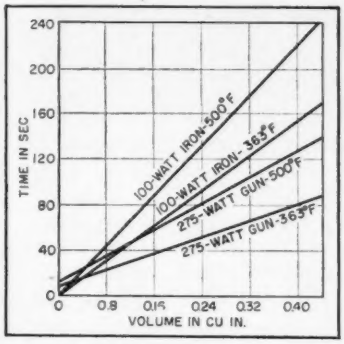
A 100-watt gun proved insufficient, but a 275-watt gun gave

satisfactory results. The regular tip was replaced with 2 pieces of No. 8 copper bus wire. The ends were filed to produce a flat contact area. The angle of the flats depends on the shape of the work being heated.

Operation

The adapted gun successfully soldered the capacitors into the chassis. The chassis became hot enough at the mounting hole to flow solder in less than 30 seconds at the heaviest point. The shield partitions required about 5 seconds each.

A preformed ring of rosin-cored solder was placed under the capacitor flange. The ring of solder also acted as a good visual temperature indicator. Only at two small spots where the tips contacted the chassis did excessive solder result. Placing the gun tips on the chassis underside improved the appearance of the chassis face.



Comparison of heating times

The gun used in this fashion has also proved useful in assembling high-frequency plumbing, making soldered connections close to thin contact-finger assemblies and making ground connections on a heavy chassis.

Heating time depends on the length of the tips used, area and volume of the work, air motion around the workpiece and tip area. Distance between the tips is adjusted by bending them.

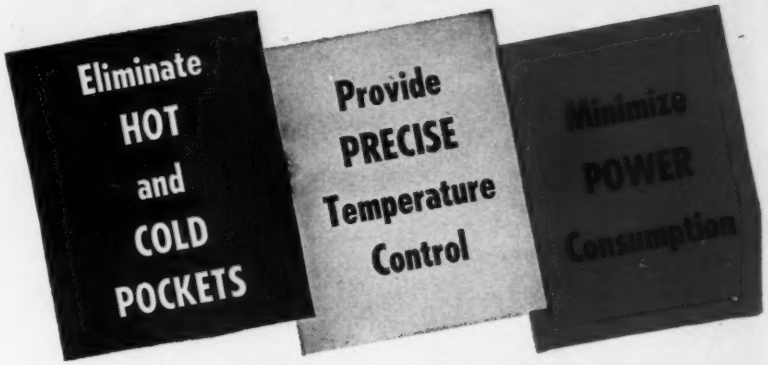
Precautions

Preparation of the workpiece surface must be observed as is any other kind of soldering. Flux is necessary. Pretinning of tips provides best contact. Precautions must be

AMINCO **Forced-Convection**

OVENS

solve the big problems



Pyrex inner-doors can be supplied for increased observation

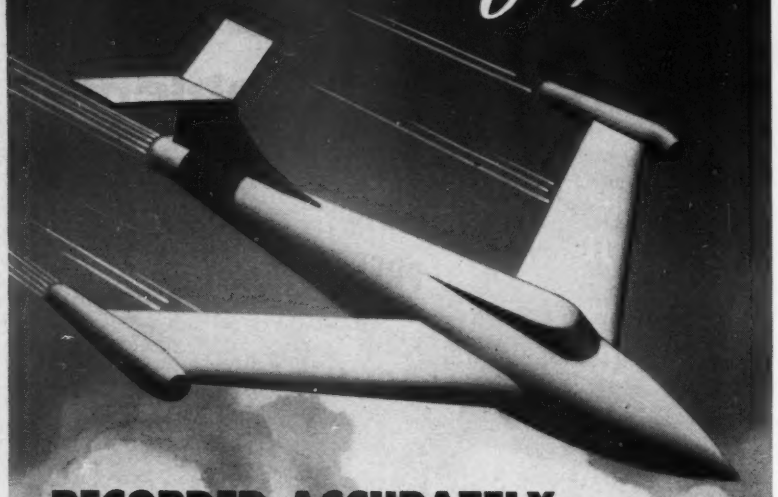
Aminco forced-convection ovens employ a motor-driven blower which produces movement of a large volume of heated air, horizontally across the work chamber. This, together with the circular arrangement of the heaters, results in uniform distribution throughout the entire work chamber. Air velocity is adjusted by means of a damper. Ovens are equipped with positive locking latches, adjustable perforated shelves, and a removable control panel.

Complete information included in **Bulletin 34-37-Z**

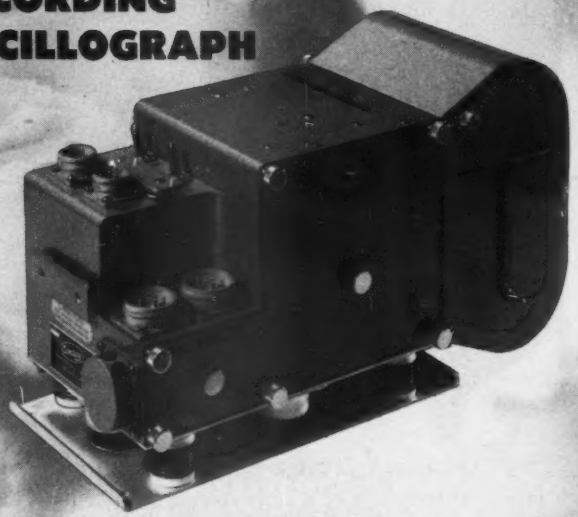
AMERICAN INSTRUMENT CO., INC.

8030 Georgia Ave., Silver Spring, Md. In Metropolitan Washington, D. C.

STABILITY *in flight*



RECORDED ACCURATELY By Century Model 409 RECORDING OSCILLOGRAPH



The Century Model 409 Oscillograph was designed for operation under the most adverse conditions, especially where space and weight considerations are limited. It is a miniature, compact unit incorporating many features found in larger models. Records faithfully during accelerations and shock in excess of 20 G's. Its size and capacity make it especially desirable for use in missile launching, parachute seat ejection, flight test of helicopter and fighter aircraft and torpedo studies.

Century Electronics & Instruments, Inc.

1333 No. Utica, Tulsa, Oklahoma

taken to avoid heat damage to the gun's transformer winding due to prolonged on-time. The operator must keep checking this danger until he becomes familiar with his gun's ability.

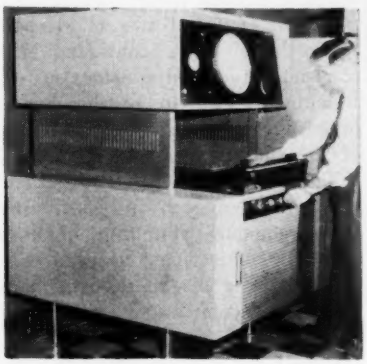
The accompanying graph shows the efficiency of a 275-watt gun used in this fashion compared with a 100-watt soldering iron. The tests were made on brass of various volumes. The heat range of 363F and 500F includes the flow temperatures of 60-40 to 40-60 solder.

Dip Solder Machine Uses Solder Pumps

By ALFRED S. KING
and
WILFRED H. HOUGH

Light Military Electronic Equipment Dept.
General Electric Co.
Utica, N. Y.

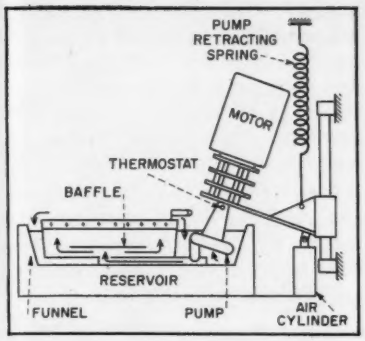
A DIP SOLDER machine flexible enough to handle the wide variety of printed circuit boards required in electronics systems manufacture has been developed for small-run production of military electronic equipment. Operation is automatic



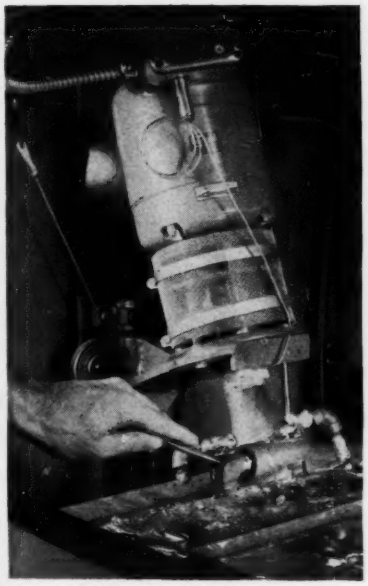
Clean cabinet design, along with handy placement of controls and instruments, contribute to operating ease of new dip soldering machine

after the board has been placed in an adjustable holding fixture.

The machine has improved board quality and cut the reject rate by 80 percent. Basic factors in the design include use of a retractible solder pump to achieve uniform



Air cylinder lowers pump into molten solder. When pump thermostat senses that solder in pump is molten, thermostat turns on pump to drive solder into funnel. Solder flows through baffles into pot to establish solder level



Solder pump is withdrawn to show pump outlet, at pencil tip. Solder inlet is in center, between dual bypass ports. Fail-safe springs at rear lift pump out of solder

temperature distribution and solder level.

A pneumatic-hydraulic device provides smooth entry and withdrawal of the board. Translational board motion during the dipping cycle increases wetting and breaks solder surface tension. The holding fixture can be rapidly changed to fit any size wiring board. Control system and cabinet are human-engineered.

▶**Heat Control**—To achieve good joints during dipping, temperature variation on the board surface and

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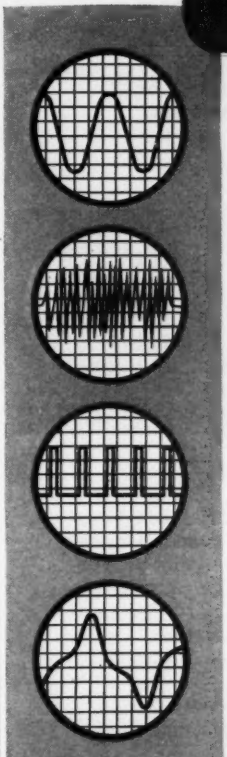
TRUE RMS

from 100 microvolts to 320 volts
REGARDLESS OF WAVEFORM
with the Ballantine Model 320 Voltmeter



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ACCURACY: .....3% from 15 cps to 150KC; 5% elsewhere
Figures apply to *all* meter readings
MAXIMUM CREST FACTORS: 5 at full scale; 15 at bottom scale
CALIBRATOR STABILITY: .0.5% for line variation 105-125 volts
INPUT IMPEDANCE: ....10 MΩ and 25 μμf, below 10 millivolts
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POWER SUPPLY: .....105-125 volts; 50-420 cps, 75 watt
Provision for 210-250 volt operation
DIMENSIONS: (*Portable Model*) .....14⅜" wide, 10⅛" high, 12¾" deep—Relay Rack Model is available
WEIGHT: .....21 lbs., approximately

PRICE: $425

(Write for the New Ballantine Catalog describing this and other instruments in greater details.

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100 FANNY ROAD, BOONTON, NEW JERSEY

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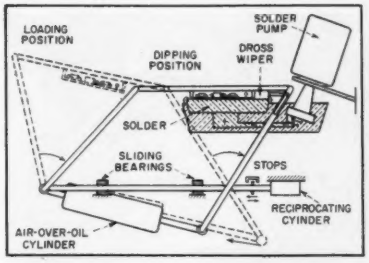
temperature drop in the solder during board entry and withdrawal are kept at a minimum. Cooling solder is constantly replaced with hot solder. A pump moves the molten solder from the pot into the funnel, over the edge of the funnel and back into the pot. This permits faster cycling than would be possible with a gravity flow reservoir and gives positive heat control.

▶**Solder Pump**—Gear, auger and centrifugal pumps were considered. The gear pump was discarded because solid particles might cause it to seize. Solder slippage between



Loading position of dipping frame is shown by dotted lines and dipping position by solid lines. Air-over-oil cylinder starts dipping mechanism and reciprocating cylinder provides translational motion

auger and sidewalls made an auger pump unsatisfactory. A suitable pump was obtained by reworking a vertical coolant pump.

During trial runs, solder inside the pump hardened when the pump was withdrawn from the pot. Upon reentry into molten solder, a further deposit solidified on the pump. This meant a 5-minute delay when the pump was raised or lowered. If the pump started before the solder was molten, the shaft would seize.

To overcome this, a thermostat, with its bulb located on the pump above the solder, was added. The initial dip still requires 5 minutes, but the pump can be raised and lowered without a 5-minute wait and seizing is prevented. The thermostat starts the pump after the correct temperature is reached.

Pump bypass ports are located below the solder surface. This prevents solder from oxidizing during passage through air and avoids particles of hardened solder in the

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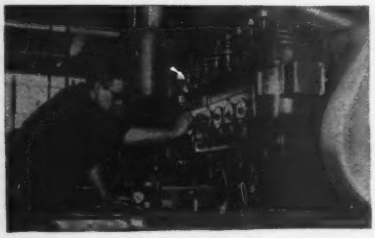

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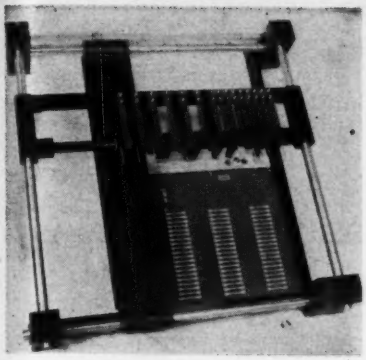


Board-holding fixture is made of black anodized aluminum and satin-finish stainless steel. Finger-type holders (top) adjust to length and hold front of board. One side holder (left) adjusts to width. The other two sides are fixed

First step in operation is lining up board

Board is slid down adjustable holding track

pot. A fail-safe mounting keeps the pump out of the solder when the pump is not running, preventing damage. An air cylinder inserts the pump and springs retract it. In case of power or air failure, the springs withdraw the pump.

▶**Translational Motion**—Relative

WAVE ANALYSER

Type **FRA1**

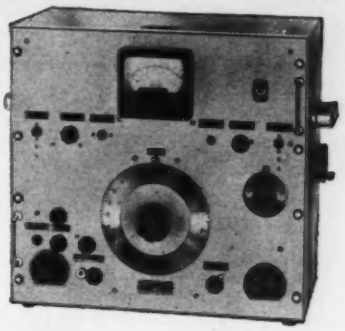
FREQUENCY RANGE:
20 cps to 16 kc/s

3 BANDWIDTHS:

	2	8	25 cps
1 dB down	±1	±4	±12.5 –
60 dB down	±35	±55	±110 –

VOLTAGE RANGES:
100 μV f.s. to 1000 V f.s.

ACCURACY:
Frequency: 1% + 1 cps
Voltage: 0.5 dB



1.5 kc/s output available for recording purposes. Direct reading ± 25 cps incremental frequency dial. Main dial logarithmic from 100-2000 cps, otherwise linear. Calibrated in volts and dB. Built-in oscillator for inter-modulation measurements supplied on request.

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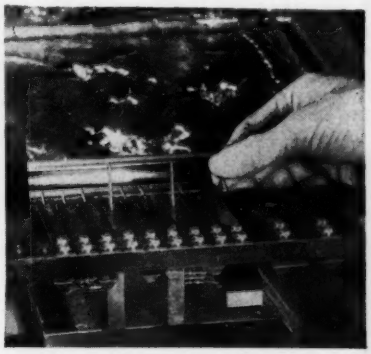
610 FAYETTE AVENUE • MAMARONECK, N. Y.

motion between board and solder improves joint quality. A reciprocating air motor provides translational motion. A time delay of ½ second prevents splash by separating transport and translational motion.

► **Operation**—A snap-action switch is tripped as the board enters the solder. The switch starts the dip timer and furnishes power to the reciprocating cylinder through the delay relay. The board comes to rest and the translation controls its motion. This time is set ½ second behind the dip time to give the board a chance to come to rest before it is removed from the solder.



Board is ready for automatic dipping cycle after support fingers are snapped into position as shown

► **Fixture**—To handle soldering for job shop production, the fixture is adjustable to a variety of board sizes. It prevents board warp by supporting all four edges. Projections may extend beyond the board edge on one side and wiring may be within $\frac{1}{16}$th inch of the board edge.

Two permanent rails, joined at right angles, provide support on rear and left side. The right side support is a movable rail, width-adjusted by sliding along tubular supports. Front support is provided by fingers.

The board is inserted in the fixture after width is set. The board is moved to the rear support. Support fingers are snapped to a vertical position and the front support frame is moved forward until it holds the board. Boards of the same dimensions are handled by

moving the fingers up for removal and down for holding.

Boards are fluxed and dried before placing in the machine. The black anodized aluminum rack is wiped with a thin film of silicone grease to prevent solder from clinging to the racks.

The cabinet design gives the operator maximum protection while emphasizing quality by an efficient-looking appearance. Adjustable legs keep the machine off the floor for easy cleaning.

Ceramic Spray Produces Radomes

Slurry of ceramic material is sprayed at high velocity on special metal mandrel which is slowly rotated by motor below

After compacting in press, protective bag is removed and radome is taken off mandrel for firing and finish-machining

NEW CERAMIC TECHNIQUES developed by Gladding, McBean & Co. of Los Angeles now make possible the manufacture of large high-alumina radomes which are mechanically strong, have high resistance to heat and erosion, and yet are transparent to radar waves. Ceramic radomes of this general type have already withstood heat and impact of reentry into earth's atmosphere after firing of high-altitude rocket.

The technique begins with high-purity alumina which is mixed with a small amount of organic binder to provide strength before firing. This is made up in the form of a slurry and is sprayed at high velocity on a special metal mandrel.

The whole assembly is then bagged and placed in a specially designed pressure reactor where it is subjected to a pressure exceeding 30,000 pounds per square inch.

At the completion of the compacting operation, the radome has sufficient strength so that it can be removed from the mandrel for a preliminary firing. The radome is then precisely machined on a lathe with a diamond tool to final shape and wall thickness. The machining makes allowance for the shrinkage which will occur during the second firing at temperatures above 3,000F.

The end product is a radome which meets electrical, thermal and present dimensional requirements. Wall thickness is held to a tolerance of plus or minus 0.001 inch, to meet bore sight specifications.

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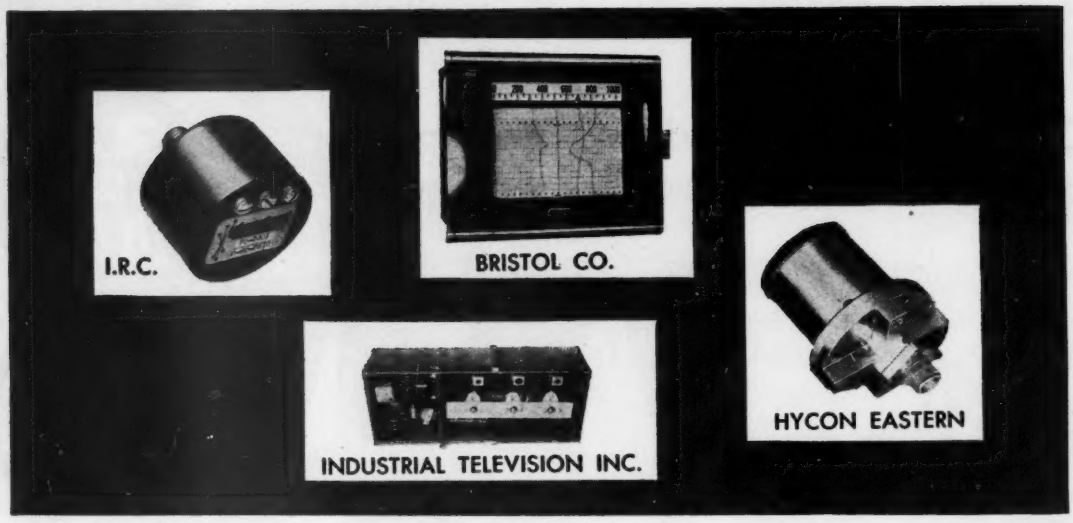


Proves Boon to Avionics

ABILITY to monitor variables from a distance is a must in the aircraft and missile industries. Hence the great demand for telemetering equipment of all types.

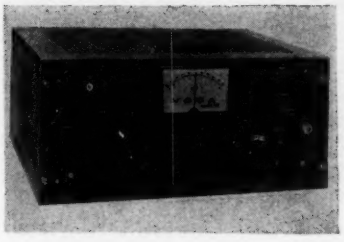
Industrial Television, Inc., Clifton, N. J., (275), is producing a crystal-controlled single-frequency receiver for telemetry and similar applications. The transistorized unit is intended for applications requiring a low power drain receiver at frequencies up to 50 mc. It can be supplied with a resonant reed type output relay to permit selective control by tone modulation, or with standard audio output circuit delivery 100 mw.

Now available at **International Resistance Co.**, 401 North Broad St., Philadelphia 8, Pa., (276), is the series 70-2000 Compu-Tran pressure pickup. These pneumatic transmitters, ½ percent devices, convert fluid pressure inputs to exact electrical equivalents. Output is in the form of precision resistance proportional to the input pressure. High level signals may be used without amplification in control, telemetering, or remote recording circuits.

Type 1231 high power telemetering diplexers have been announced by **Hycon Eastern, Inc.**, 75 Cambridge Parkway, Cambridge 42, Mass. (277) They feed signals from two 100-w transmitters into a single missile antenna system, satisfy military requirements for use in test missiles and supersonic aircraft for telemetering.

The Bristol Co., Waterbury 20, Conn., (278), has a multiple-printing strip-chart Metameter telemeter receiver. It will print out up to 16 separate records from as many telemetering transmission centers. Using multiple-switching, it can monitor a large number of values from any distance necessary. The variables need not be all of one kind, but could be a combination of pressure, flow, temperature, liquid level and the like.

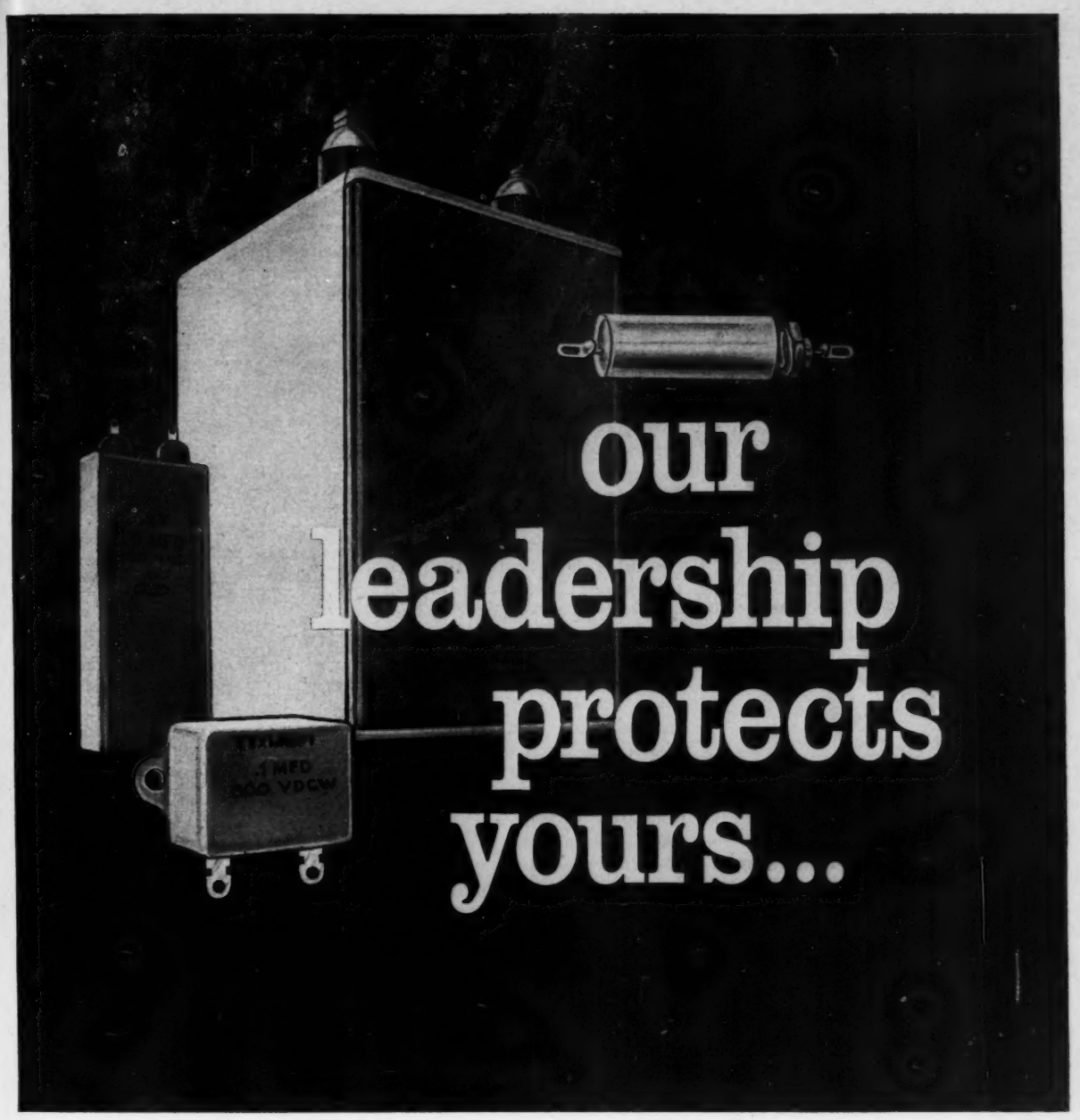
For more information use READER SERVICE CARD



Voltmeter-Calibrator Multifunctional unit

DEMOLAB CORP., Instrument Div., 1550 No. Highland Ave., Hollywood, Calif., has developed a multifunctional instrument called the VOCA. It combines a precision differential null type potentiometric voltmeter and calibrator for a-c and d-c and vtvm. The potentiometric differential null type of measurements, once limited to d-c voltages only, can also be applied to rms sine wave voltages, and the built-in accurate and stable reference standards are now available for calibrator functions.

The VOCA can be used for calibrating other types of instruments such as multimeter, vtvm's, regulated power supplies and oscilloscopes. For component, circuit test and design use the d-c and square



Our reputation as the world's most Consistently Dependable producer of capacitors has been maintained for over 46 years. But *any* reputation can be lost overnight. That's why we resist the temptation to gain temporary advantage through methods that risk *our* reputation or yours. C-D's Consistently Dependable products can mean PLUS dollars to you.

Widest Choice of Impregnants and Dielectrics to meet your needs: More than a score of liquid and solid impregnating media and dielectrics, including Polystyrene, Mylar*, Teflon, metallized paper and metallized Mylar, are readily available to meet your temperature, size and other circuit requirements. Operating temperature ranges from −40°C to +85°C and −60°C to +200°C. Whatever your capacitor problems, depend on Cornell-Dubilier to fulfill your needs most promptly, most economically and most satisfactorily.

Write for catalog to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

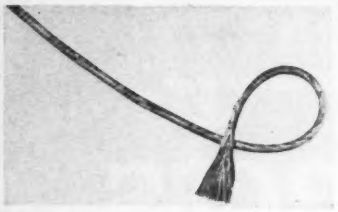
(*DUPONT TM)

CONSISTENT HI-DEPENDABILITY
CORNELL-DUBILIER CAPACITORS

SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER & CAMBRIDGE, MASS.; PROVIDENCE & HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD, FUQUAY SPRINGS & VARINA, N. C.; VENICE, CALIF.; & SUB.: THE RADIART CORP., CLEVELAND, OHIO; CORNELL-DUBILIER ELECTRIC INTERNATIONAL, N. Y.

wave reference voltages can be used to accurately determine circuit biasing levels and triggering levels with a very close accuracy as applied to component, vacuum tube and transistor applications.

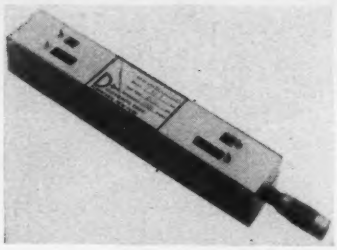
A comprehensive accessory line is being offered, consisting of input probes to extend the frequency range over a wide spectrum from d-c to uhf; precision shunts for a-c and d-c current readouts; and a group of plug-in units to provide an extremely wide variety of output functions referenced against the precision standard accuracy and stability of the basic instrument. **Circle 279 on Reader Service Card.**



Zipper Tubing
Reduces time and labor

ALPHLEX TUBING DIVISION OF ALPHA WIRE CORP., 200 Varick St., New York 14, N. Y. Zipper tubing, a harnessing and cabling technique constructed of polyvinylchloride plastic, is strong, flexible, durable and low-cost. Because it is supplied flat and open (the user zips it to close) no minimum orders nor expensive extrusion set-up charges are necessary. Its ease of accessibility for wire changes, and its high versatility make it unexcelled for prototype work. It is a labor saving device for production applications.

General purpose type ZIP-31 meets MIL-I-631C specifications. Type ZIP-44 (Air Force approved) meets MIL-I-7444A (Amendment I) specifications. Standard wall thickness is 0.020 in. ± 0.001 in. Alphlex zipper tubing can be sealed permanently with a liquid sealer. It is available in all put-ups from 10 ft to 1,000 ft in clear or black, in sizes from ½ in. i-d to 4 in. i-d. Other factors are available to special order. **Circle 280 on Reader Service Card.**

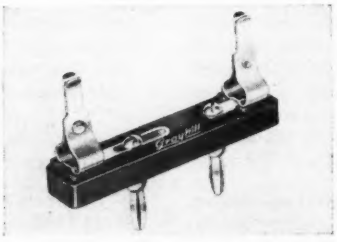


C-V Delay Lines
Flexible and versatile

DIGITRONICS CORP., Albertson Ave., Albertson, N. Y., announces continuously variable delay lines featuring infinite resolution, no sliding contacts and having a calibrated delay accuracy of better than one percent. The temperature coefficient is approximately 0.005 percent per deg C over a range of from − 40 C to + 85 C. The lines are externally terminated in characteristic impedance. Internal termination is optional. The units are readily adaptable to servo systems and automatic tracking devices. They can be combined as required, with belt or gear drive.

Standard models offer a range of from 0.06 − 0.10 μsec (for the 1R-.1-1000 model) to 3.30-5.00 μsec (for the 1R-5-1000 model). Impedance level is 1,000 ohms. Elements of 500 ohms and 2,000 ohms are available.

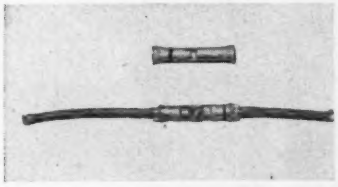
Rise time for the 0.06 to 0.10 μsec delay element is 0.02 μsec. For the 3.30 to 5.00 μsec delay element the rise time is 0.40 μsec. Other delay ranges are available on request. **Circle 281 on Reader Service Card.**

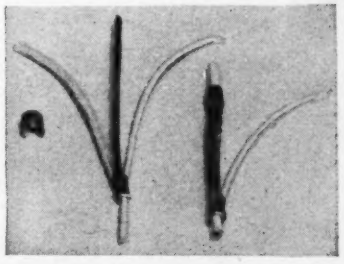


Test Clip Adapter
Fits banana type jacks

GRAYHILL, INC., 561 Hillgrove Ave., La Grange, Ill., has placed on the market a universal test clip adapter to fit all banana type jacks. It features spring-tension test clips on top for simplified testing of resistors, capacitors, germanium diodes and similar lead wire type components. Banana jacks underneath may be adjusted to satisfy any banana plug spacing from standard ¾ in. centers to 1¼ in. centers.

Nickel plated spring clips insure positive contact every time. The base is of electrical grade molded phenolic. **Circle 282 on Reader Service Card.**





Splices/Ferrules
One-piece construction

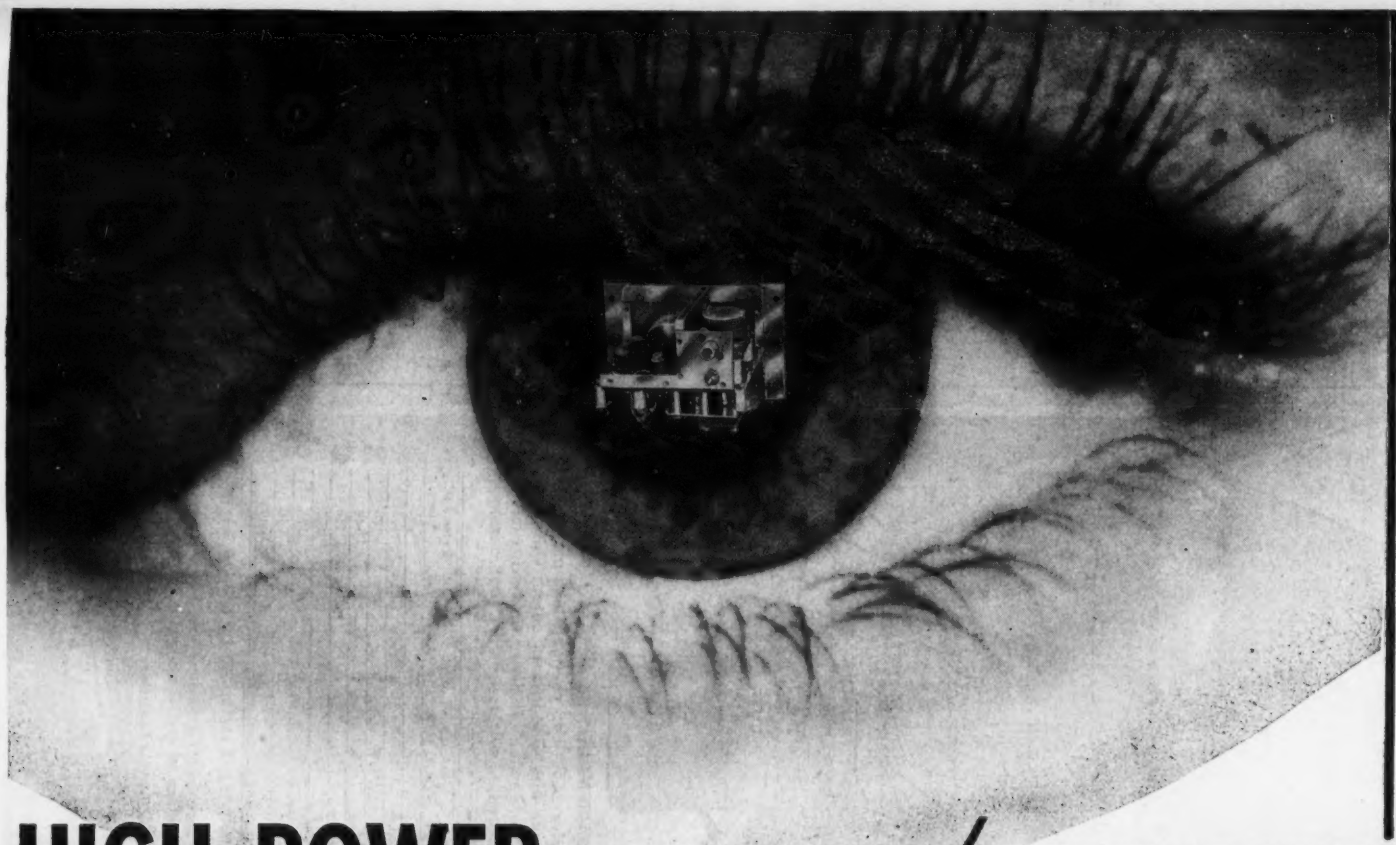
AMP, INC., Harrisburg 12, Pa. The new team of shielded wire splices and shielded wire ferrules gives faster, more compact splicing. The splice, between two shielded wires, is made by crimping the connector on the end of each wire with a recommended A-MP hand crimping tool or appropriate power tooling. Grounding connections are made with the shielded wire ferrule and similar tooling.

Color coding of both the connector and tooling assures correct match of wire, splice and tooling. Splices and ferrules are color coded to follow RETMA standards.

A rectangular center window in the connector assures positive wire depth in barrel and inspection ports at each end assure definite braid enclosure.

Both splices and ferrules feature

Direct FM Transmitters Crystal controlled 215-235 megacycles. 125kc deviation.



HIGH POWER

in Small Packages

Unhampered by traditional thinking, TELECHROME engineers have developed an entirely new concept in telemetering equipment — unequalled in compactness, ruggedness and dependability. **Write for Specifications & Details**

FOR MESSAGES FROM OUTER SPACE

TELEMETERING TRANSMITTERS

by

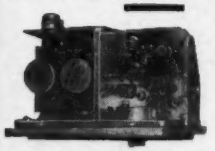
CHROME MFG. CORP.

The Nation's Leading Supplier of Color TV Equipment

28 RANICK DRIVE, AMITYVILLE, N. Y. • Lincoln 1-3600

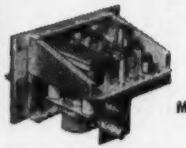
Western Engineering Division — 13635 Victory Blvd., Van Nuys, Calif., State 2-7479

Direct FM Transmitters Crystal controlled 215-235 megacycles. 125kc deviation.



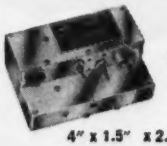
Model 1462

8" x 4¼" x 3¾" 50 to 80 Watts



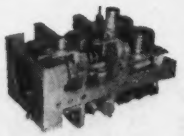
Model 1463

5 1/32" x 3 3/16" x 4" 15 to 30 Watts



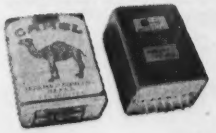
Model 1472

4" x 1.5" x 2.7" 2 Watts



Model 1466A
6.5" x 4" x 3.25" RF Amplifier
2 watts in — 100 watts out

SUB-CARRIER OSCILLATOR.

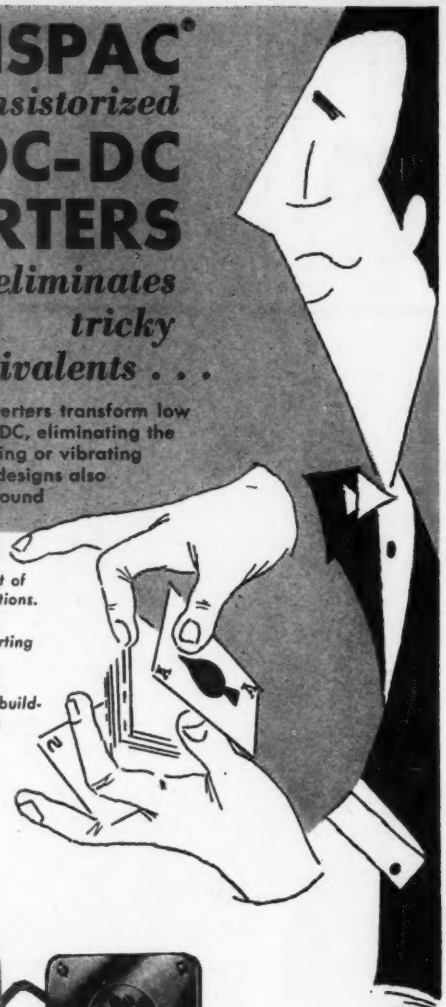


Model 800C — 1.5" x 1.9" x 2.45"

Deviation stability ±1% of band width. Deviation linearity less than 1% of band width under all conditions measured from a straight line drawn between end points.

TRANSPAC®
Transistorized
DC-DC CONVERTERS
eliminates tricky mechanical equivalents . . .

Transpac® semi-conductor converters transform low voltage DC into higher voltage DC, eliminating the disadvantages inherent in rotating or vibrating mechanical equivalents. These designs also incorporate exclusive features found only in the ERA line . . .



®Trade Mark Registered

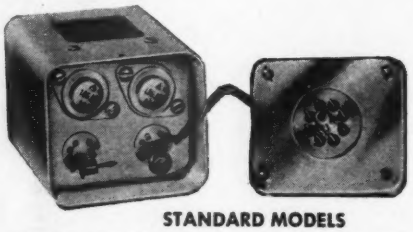
'E' CORE DESIGN . . . *decreases effect of temperature and environmental conditions. Uniform performance unit to unit.*

SELF STARTING . . . *utilizes diode starting network for positive starting under all operating conditions.*

DE-SPIKING NETWORK . . . *prevents build-up of excessive voltages insuring long life and reliable operation.*

ACCESSIBILITY . . . *plug-in design, transistors and similar components easily accessible for servicing and replacement.*

RELIABLE DESIGN . . . *uses high temperature components, overload and short circuit protected.*



STANDARD MODELS

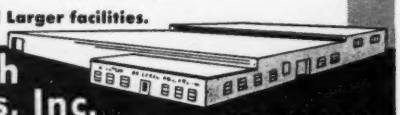
Output regulation less than 5% for 25% load change. Units may be operated over wide range of input with proportional output voltage change. Ripple less than 0.2%. Conversion efficiency approximately 80% (24V. units). May be operated in excess of 75°C but derate 1 watt/°C for operation above 65°C.

Model No.	Input VDC	Output VDC	Output Current	Output Watts, Max.	Size Inches	Weight Pounds	Price FOB, Factory
TC617	6	150	75 ma	12	C	2.0	$95
TC111	12	150	100 ma	15	C	2.0	115
TC121	12	250	100 ma	25	D	2.7	125
TC131	12	350	100 ma	35	D	2.7	140
TC211	24	150	100 ma	15	C	2.0	115
TC212	24	150	200 ma	30	D	2.7	125
TC221	24	250	100 ma	25	D	2.7	125
TC222	24	250	200 ma	50	D	4.0	140
TC231	24	350	100 ma	35	D	2.7	140

Case Size, WxDxH Ins.: "C" 2-3/8, 2-3/4, 3-13/16; "D" 2-5/8, 3-1/6, 4-1/4;

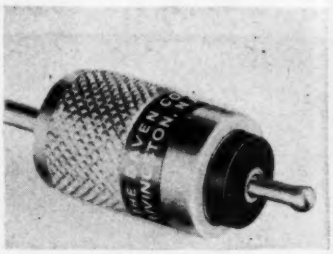
Custom designs and additional standard model converters and inverters also available. Write for literature and quotations on special designs.

Manufactured at ERA's New and Larger facilities.



Electronic Research Associates, Inc.
67 Factory Place, Cedar Grove, N. J.
CEnter 9-3000

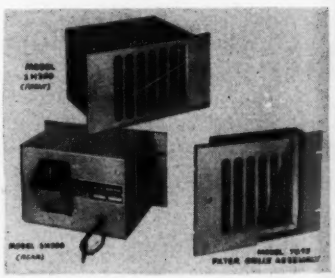
one-piece construction. There are no loose pieces required to make the connection, thus bringing application time and costs to a minimum. **Circle 283 on Reader Service Card.**



Video Termination For 75-ohm coax lines

THE DAVEN CO., Livingston, N. J., has developed a new video termination for 75-ohm coaxial transmission lines. Type FR-300 termination has the following characteristics:

(1) A turret type lug at the rear of the termination provides a connection point for an oscilloscope. (2) Negligible reaction—less than 2 deg phase shift—up to 250 mc. (3) Deposited carbon resistor rated at ½ w; accuracy, 1 percent. (4) Nominal resistance 75 ohms; other values available on special order. (5) R-F resistance at 100 mc is within −1 percent of the d-c value. (6) Terminations are housed in standard uhf type connectors. (7) Length is 2 in., and diameter, ¾ in. **Circle 284 on Reader Service Card.**

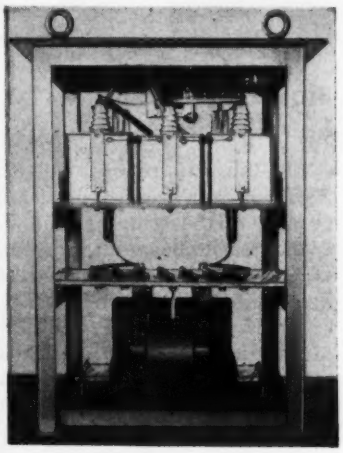


Small Rack Cooler Big space saver

MCLEAN ENGINEERING LABORATORIES, P. O. Box 228, Princeton, N. J. Model 1 H 300 is a rack

mounted centrifugal blower type package, only 5¾ in. high with a 9¼ in. panel width (2 to a regular 19 in. rack if required). It is designed to cool electronic racks employing space saving miniature components. The blower delivers 100 cfm, is equipped with a large permanent type filter and a stainless steel grille.

In conjunction with this unit a series of matching filter grille assemblies is available. These have been developed as air outlets and to prevent the back flushing of dust when blower is not operating. Filter acts as an r-f shield for electrical radiation. It may also be used as an inlet for filtered air if an exhaust fan is used. These assemblies may be mounted on the upper part of the cabinet—top, front or rear. **Circle 285 on Reader Service Card.**



H-V Power Supply
Low corona, low ripple

DEL ELECTRONICS CORP., 521 Homestead Ave., Mt. Vernon, N. Y. This 0-30 kv d-c at 3 ma power supply features an oil immersed h-v unit with selenium rectifiers and filter to give 0.001 percent ripple per ma. Output polarity is reversible by a plug-in arrangement.

The control is rack mounted and provided with means of varying the output voltage from 0 to full 30 kv d-c. An illuminated kilovoltmeter and a three-range illuminated microammeter are provided with a dimming control which varies the illumination from maximum to

Sorensen DFCD 250-2AR developed for Arma Corporation

Sorensen Specifies
G-V Thermal Time Delay Relays
"...to enhance reliability..."

In this B-52 power supply control unit, developed by Sorensen & Company, a G-V relay serves as the initial time delay to protect functional thyratron circuitry. Another G-V relay recycles the equipment under overload conditions. Sorensen states that, "These G-V units enhance system reliability and extend life of thyratron tubes and all other circuitry".

In both military and industrial equipment, G-V thermal relays are providing long, dependable, proven service in time delay applications, voltage and current sensing functions and circuit protection.

Write for extensive application data and catalog material.

G-V.

G-V CONTROLS INC.
24 Hollywood Plaza, East Orange, N. J.

CIRCLE 55 READERS SERVICE CARD

MARCONI

FM SIGNAL GENERATOR

Covers all Mobile Communication Bands

The new Marconi Signal Generator Model 1066/1 meets all requirements for the design and maintenance of f.m. equipment in the range 10-470 Mc. Here is the precision Marconi instrument for this exacting job.

The oscillator works on fundamentals throughout and there are no spurious sub-multiple outputs; its temperature compensation and fully-regulated plate and filament supplies give excellent frequency stability. A magnetically-biased ferrite frequency modulator ensures rock steady deviation characteristics. Other major features are the Marconi-patented contactless range turret and a 50Ω piston attenuator which is truly resistive. Engineers will appreciate the separate incremental frequency controls with meter calibration; these enable precise f.m. carrier shifts of as little as 1 kc in 450 Mc without readjustment of main frequency control.

MARCONI F.M. SIGNAL GENERATOR MODEL 1066/1

Abridged Specification

Frequency Range: *10 to 470 Mc in five bands — all on fundamentals.* Frequency Stability: *Better than 0.0025% per 10-minute period after warm-up.* Modulation: *0 to 20 and 0 to 100 kc deviation monitored and continuously variable; amplitude modulation to any depth up to 40% is also obtainable.* Modulation Frequencies: *1 and 5 kc.* Distortion due to Modulator: *Less than 1%.* Output: *0.1 μV to 100 mV across a 50Ω termination.* Output Accuracy: *Incremental, 0.2 dB: within 2 dB overall.* Leakage: *Negligible; allows full use of 0.1 μV output.* Incremental Frequency Controls: *Variable, 0 to ± 100 kc. Stepped ±5, 10 and 15 kc.* Tubes: *5Z4G, 6AK6, 6CD6G, 6AK5, 5861, 6C4, 6L6G, 12AT7, OB2, 5651.*
Marconi F.M. Deviation Meters 791C and 934 are companion instruments. Send for leaflet B/114A for full details.

MARCONI INSTRUMENTS

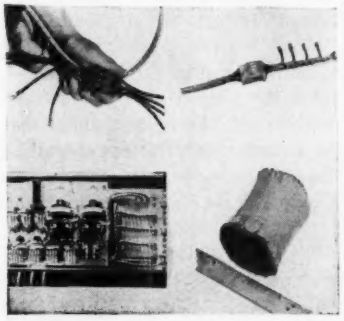
Marconi for f.m. test gear

111 CEDAR LANE · ENGLEWOOD · NEW JERSEY · Tel: LOwell 7-0607
CANADA: CANADIAN MARCONI COMPANY · 6035 COTE DE LIESSE · MONTREAL 9
MARCONI INSTRUMENTS LTD · ST. ALBANS · HERTS · ENGLAND

TC 114

zero, so that the unit can be used in total darkness. An alarm circuit audibly warns of danger when the power is turned on, and an automatic h-v switch discharges the energy stored in the capacitors, when the power is turned off.

The h-v unit is housed in a heavy gage steel oil tight tank with four eyebolts for lifting. It is 16½ by 16½ by 22⅛ in. high. **Circle 286 on Reader Service Card.**

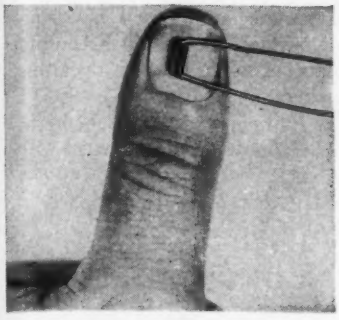


Plastic Wrapping Spirally-cut

AMP Inc., Harrisburg 19, Pa. AMP-Spirap, a recently developed product of the company, and its application technique will speed, simplify, and obsolete many present time-consuming subassembly operations. It is a unique, spirally-cut plastic wrapping that: eliminates tedious cable lacing, insulation damage, and pulling of wires through spaghetti tubing; is quickly applied to wire bundles of any size up to 3½ in. diameter; permits individual wires to be entered or led out at any point; is quickly unwound to allow wires to be added, removed or relocated—thereby eliminating the necessity for cutting into the cable bundle after assembly; holds wires together tightly, but permits flexibility for forming cable; and provides mechanical protection over entire length of cable.

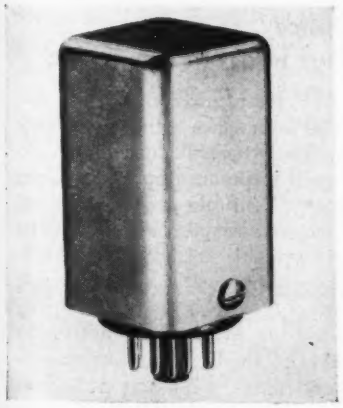
Photograph (from upper left to lower right corner) shows: (1) Spirap being applied to an electrical harness. (2) The harness is completely wrapped (wires easily leading out at various points along the wrapping). (3) Spirap applied to a control panel. (4) Spirap ap-

plied to a wire bundle of 3½ in. diameter. **Circle 287 on Reader Service Card.**



Precision Resistor Is subminiaturized

EASTERN PRECISION RESISTOR CORP., 675 Barbey St., Brooklyn 7, N. Y. The NS6AZ is a precision wirewound resistor measuring 0.125 by 0.250. One in a line of over 15 sizes encapsulated to meet MIL R93A characteristic "A" and MIL R 9444, they are available with resistance values up to 125 K with tolerance to 0.1 percent. This resistor will dissipate 0.1 w at 125 C with no derating. **Circle 288 on Reader Service Card.**

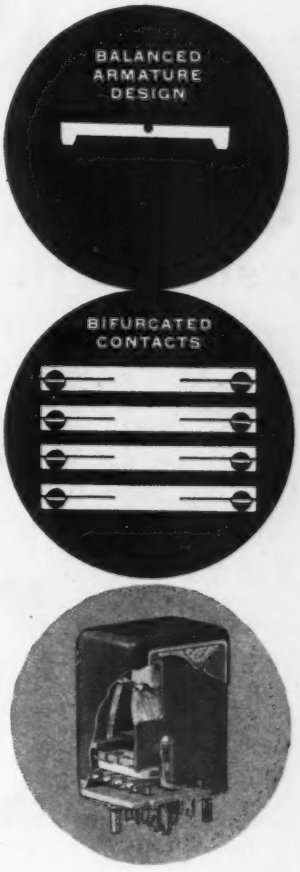


Tape Head Preamp Three-stage unit

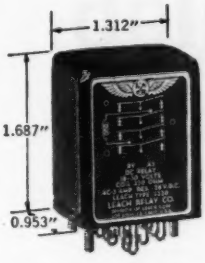
ELECTRO-VOICE, INC., Buchanan, Mich. Model 6010 magnetic tape preamplifier is a three-stage transistor preamplifier designed for playback use with magnetic tape

LEACH

balanced armature relays help you solve electronic circuit problems



First proven in all types of advanced aircraft, Leach *Balanced Armature* relays are now solving the most exacting problems for systems designers. Exclusive balanced armature design eliminates faulty operation of contacts due to vibration and shock forces. Bifurcated contacts assure high reliability in contact-making circuits. You'll find that these unique relays outperform all other types in resistance to shock, acceleration and vibration.



9220... Balanced Armature relay. Rectangular configuration...with a variety of mountings and terminals available. Hermetic sealing is 100% tested by mass spectrometer.

Typical Ratings

Normal operating voltages—6-115 vdc, 115 vac (400 cycle), 4 PDT.
Contact ratings @ 28 vdc or 115 vac single-phase
Resistive – 3 amp @ 120°C
– 5 amp @ 85°C (dc only)
Inductive – 1.5 amp @ 85°-120°C
Motor Load – 1.5 amp @ 85°-120°C
Rated duty – continuous
Minimum operating cycles – 100,000
Weight – 0.25 to 0.30 lbs.
Shock – 50 G's
Vibration – 10 G's, 0-500 cps
Applicable specifications – MIL-R-6106B, MIL-R-5757C
Also available in units to meet the minimum current requirements of MIL-R-6106C
We invite other special requirements such as microamp switching, high vibration and special mountings.

See for yourself

Write today for your copy of the Leach *Balanced Armature* Catalog describing relays for electronic and missile applications.

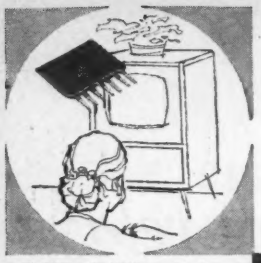
LEACH

CORPORATION

Leach Relay Division

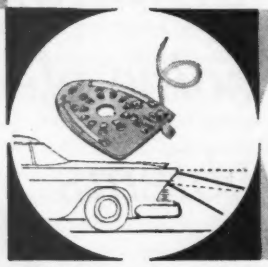
5919 Avalon Boulevard
Los Angeles 3, California

District Offices and Representatives in Principal Cities of U. S. and Canada

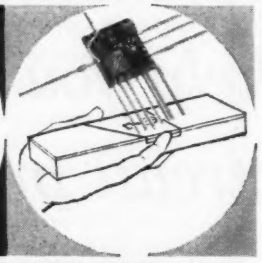


Proof of Reliability and Versatility...

TV SETS—17 PEC's replaced over 100 parts, simplifying assembly and improving performance.



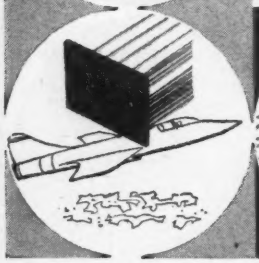
AUTOMOTIVE — PEC provides photo-multiplier tube socket and 20 resistors in one unit.

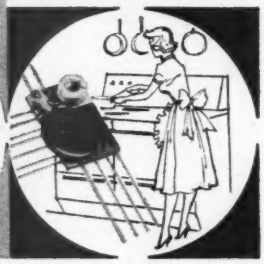


PORTABLE RECORDER — PEC amplifier provides large recorder quality in miniature tape recorder.

85,000,000 PEC's*

used in the past decade...





for these and many other applications

Centralab

ELECTRONIC ORGAN — PEC filter reduces sharp transient of keying to give natural touch response.

JET AIRCRAFT — PEC's simplify assembly of instrument panels... guarantee circuit performance.

ELECTRIC APPLIANCES — PEC in surface burner control finer selectivity of temperature.

Centralab PEC's — combining capacitors, resistors, inductors, and wiring in one compact sub-assembly — were originally designed for military applications. And due to their reliability and versatility, more than 85,000,000 have been used during the past ten years to guarantee circuit performance in countless electronic products. New developments promise even greater design flexibility for future applications.

Centralab — originator and undisputed leader in PEC development — offers you modern facilities and 35 years of experience to provide the packaged electronic circuit your product design requires. Write for complete information on products and service.

Centralab A DIVISION OF GLOBE-UNION INC.

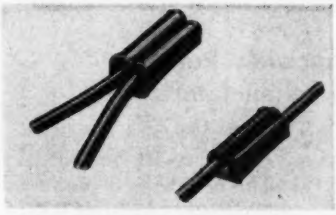
914A E. Keefe Avenue • Milwaukee 1, Wisconsin

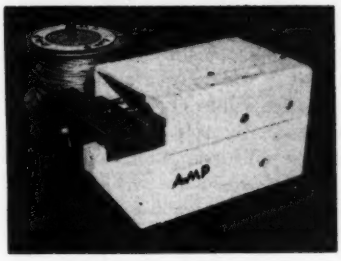
In Canada: 804 Mt. Pleasant Rd. • Toronto, Ontario

Y-4058

*Trademark (Packaged Electronic Circuits)

heads. The unit compensates to the standard NARTB curve ± 0.7 db from 20 cps to 20 kc. Gain at 1 kc is 42 db. Precision low noise resistors and selected transistors assure unusually low noise output of only 400 μv, unweighted. Maximum output is 1.5 v rms. Input impedance is 40 K; output impedance is 15 K; operating temperature maximum is 40 C. The unit is packaged in a $1\frac{3}{8}$ by $1\frac{3}{8}$ by $2\frac{5}{8}$ aluminum can provided with an octal base for ease of installation. **Circle 289 on Reader Service Card.**

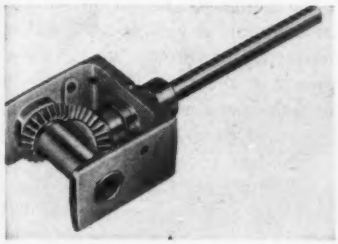




Splice
Plus horizontal machine

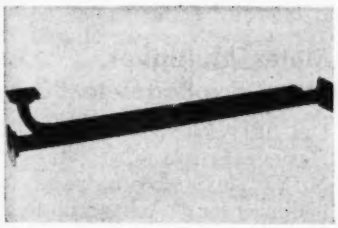
AMP, Inc., Harrisburg 13, Pa. The AMPli-var splice with its automatic horizontal splicing machine is designed to produce up to 1,200 per hour identical, mass produced splices on enamel, polyvinyl acetal and similarly coated wire. AMPli-var splices, with multiple ring stripping action, eliminate scraping, dissolving in solvents, burning or other methods of removing insulation. There is no heat damage as in other methods of splicing. The splice, scarcely larger than the wires themselves, is design-engineered to lock wires and connector into a high tensile strength splice. The joint is hermetically sealed during splicing, thus rendering it corrosion resistant. Soldering material and

equipment are unnecessary; less wire and time are required, thereby lowering installed costs. AMPli-var splices can be used on solid or stranded conductors or combinations thereof. **Circle 290 on Reader Service Card.**



Right Angle Drive Precision device

NATIONAL CO., INC., 61 Sherman St., Malden 48, Mass., introduces a new Blue Chip precision right angle drive intended primarily for remote operation of low torque units such as tuning capacitors or potentiometers. It may be used for continuous operation at low speeds with loads up to 50 in. oz. It will tolerate intermittent high speed operation (up to 500 rpm) with loads up to 100 in. oz. Backlash is less than 1.5 deg. Unloaded running torque is less than 2½ oz. Gears are brass; shafts and bushings, stainless steel; housing, die cast zinc. Size is 4 9/16 in. long by 6 3/4 in. wide. **Circle 291 on Reader Service Card.**



Microwave Couplers High directivity type

THE NARDA MICROWAVE CORP., Mineola, N. Y., has introduced two new series of high directivity couplers, of 3 db and 6 db values, with

HI-VAC's compact, multipurpose HIGH VACUUM BELL JAR UNIT

. . . is unequalled in quality and performance—and unmatched in price!

HI-VAC's Bell Jar Unit is ideally suited for vacuum evaporation of either reflective or non-reflective coatings for experimental and small piece production.

Here are the reasons for its superiority:

- **HIGHEST ULTIMATE VACUUM** — Capable of continuous operation in the 10^{-6} mm Hg range—*unequalled.*
- **HIGHEST PUMPING RATE** — Evacuates a clean, dry outgassed system to 0.1 micron in less than 3 min. —*unequalled.*
- **EXTREME VERSATILITY** — Because of its modular construction the unit readily adapts to a wide range of applications.
- **REQUIRES NO SERVICING** — . . . because of its unique construction.

ADDITIONAL FEATURES OF HI-VAC's BELL JAR UNIT:

- Synthetic "O" rings are used to prevent outgassing.
- Diffusion pump and all high vacuum manifolding is of polished stainless steel—eliminates rust, corrosion and outgassing.
- High vacuum manifold is always under vacuum — maintains a "clean" system and reduces pumping time.

The unit is available in three sizes, with either a 520, 640 or 1800 cfm diffusion pump. Each unit is housed in a modernly designed heavy-gauge steel cabinet . . . 25x 23x38" high . . . with a gray hammertone finish. Complete information available on request.

HIGH VACUUM EQUIPMENT CORPORATION manufactures a complete line of standard vacuum metalizing units (up to 72" dia.); induction, resistance, and arc furnaces; pumping systems and related components.

HIGH VACUUM EQUIPMENT CORPORATION

HINGHAM, ——— MASSACHUSETTS

HI-VAC

INDIUM

Metallurgists and engineers in many industries are making startling advances through use of INDIUM in one or more of its various commercial forms. Even we can't begin to imagine the rapidly expanding range of applications.

You may have a product development problem for which INDIUM might be the answer. Why not write us and investigate the possibilities?

QUALITY
at the Indium Corporation of America means: purity of metals, and strict adherence to specifications.

SERVICE
means prompt delivery to customers, and technical help in specific uses of INDIUM.

RESEARCH
means "forward looking" with respect to new products and new techniques.

COMMERCIAL QUANTITIES AVAILABLE:

- Indium metal (specially refined 99.999% pure)
- Indium metal (99.97% pure)
- Indium wire
- "Indalloy" intermediate solders
- Indium pellets
- Indium spheres
- Indium powders
- Other high-purity metals

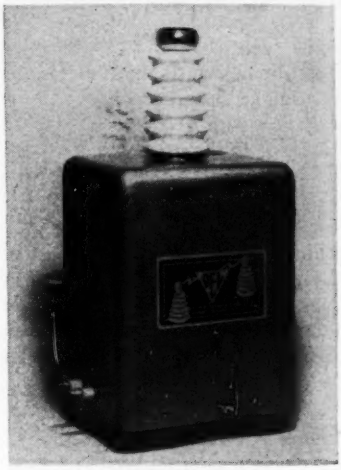
Write Dept. E-1 for new INDIUM bulletin:
"Indalloy" intermediate solders

THE **INDIUM** CORPORATION OF AMERICA
1676 LINCOLN AVENUE UTICA, NEW YORK
Since 1934 . . . Pioneers in the Development and Applications of Indium for Industry.

six models in each category covering the frequency range from 2.60 to 18.0 kmc.

The new units, like the 10, 20 and 40 db models, are multi-holed and consist of a primary and secondary line with the coupling holes contained in a common wall. In the new series, this common wall is the broad wall and therefore permits a high degree of uniformity of coupling as well as a minimum frequency sensitivity to be maintained in the unit. (In the 40 db models the coupling irises are in the narrow wall.)

Standard cover flanges terminate both ends of the primary line. One end of the secondary line has a built-in low vswr termination to insure high directivity. The other end of the secondary arm is terminated with a standard cover flange. **Circle 292 on Reader Service Card.**



Meter Multiplier
For d-c voltages to 30 kv

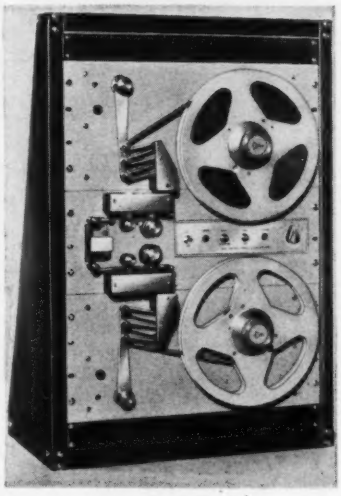
DEL ELECTRONICS CORP., 521 Homestead Ave., Mt. Vernon, N. Y. An inexpensive voltmeter multiplier for d-c voltages up to 30 kv consists of stabilized resistor immersed in high grade insulating oil. The assembly is sealed in a standard LA can and provided with a porcelain anti-corona insulator.

The meter terminals are protected with an internally connected glow discharge tube to prevent the

voltage at these terminals from exceeding safe values if the meter should become disconnected.

Designed for 110 μa meter movements, the accuracy is within $\pm$ 2 percent. A 4 in. panel meter calibrated 0 to 30 kv for use with this multiplier is also available.

Other units in the voltage range from 5 to 150 kv d-c can be supplied. **Circle 293 on Reader Service Card.**



Tape Handler
For digital computers

DIGITRONICS CORP., Albertson Ave., Albertson, N. Y. Increased tape speed of 75 ips and 40 start-stop cycles per sec is now available in the new model 101 digital magnetic tape handler. With suitable read head and reel adapters, the tape produced is compatible with IBM computers.

A variety of models provides a wide choice of specifications. As few as 6 and as many as 20 tracks are available. Choice of tape speeds range from 2 to 75 ips. Complete remote control of start, stop, reverse and speed change functions is furnished as well as single or dual tape speeds as required.

Two fast-acting solenoids press the magnetic tape against either of two continuously rotating capstans to start the tape in less than 5 millisec. Equally fast stops are obtained by dual braking solenoids that press the tape against stationary

ACESETS shown approx. ½ size

Now you can select from nine different resistance values and improve the accuracy and dependability of your circuit performance. ACESET precision, wire-wound, micro-miniature potentiometers offer greater stability under temperature cycling through the use of 20 ppm temperature coefficient wire. Improved performance at lower costs have been achieved by mass producing to standard specifications. Shipments are guaranteed within 24 hours of receipt of order. Call, wire or teletype Dept. F at Ace Electronics Associates, Inc., 99 Dover Street, Somerville, Mass. SOmerset 6-5130. TWX SMVL 181

MECHANICAL SPECIFICATIONS

One piece precision-machined metal case
Passivated stainless steel shaft
Self-contained locking device
Panel anti-rotation pin
Mechanical rotation: 330° nominal
Size: ½" diameter x 5/16" body length

ELECTRICAL SPECIFICATIONS

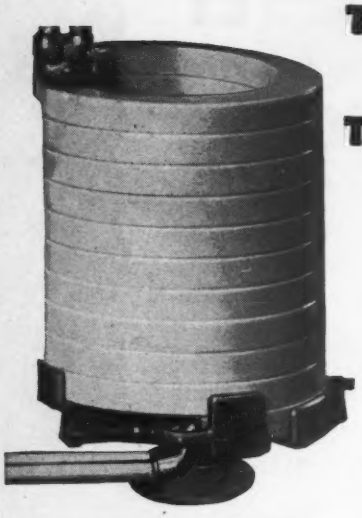
Heat Dissipation: 2 watts at 60°C.
Voltage breakdown: 1,000 VDC
Electrical Angle: 325° nominal
Temperature coefficient of wire: 20 ppm
Resistance tolerance: ±10%
Linearity: ±5%

ACE ELECTRONICS ASSOCIATES, INC.

*TRADEMARK APPLIED FOR

ACEPOT® ACETRIM* ACEOHM® ACESET®

LAPP COOLING GIVES LONGER LIFE TO HIGH-POWER TUBES



WATER-COOLED

Carrying cooling water which must undergo a change in potential is a job best handled by Lapp Porcelain Water Coils. These coils are completely vitrified, non-absorbent porcelain, white glazed inside and out, providing very low resistance to water flow and eliminating all possibility of contamination in the water. Assuring positive cooling and long tube life, a Lapp Porcelain Water Coil installation represents a permanent investment—a completely trouble-free cooling system.

AIR-COOLED

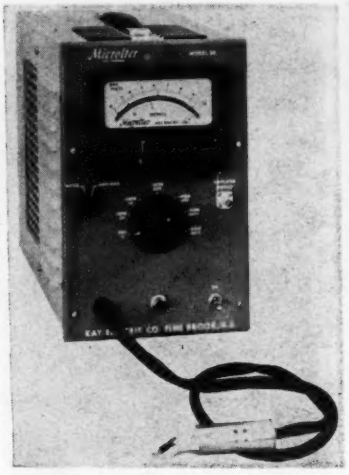
Use of Lapp standard-design tube supports facilitates circuit design, improves production economy, provides interchangeability and easy replacement. They are compact, efficient and attractive in appearance, with polished nickel-plated brass hardware permanently attached to the body. Equipment manufacturers will realize a triple service from these supports, for they support the tubes and act as an insulator, and channel air over the fins for maximum cooling of tubes.

WRITE for Bulletin 301 containing complete description and specification data. Lapp Insulator Co., Inc., 138 Sumner Street, Le Roy, New York.

Lapp

capstans as it is released from the driving capstans.

The extreme reliability and precision required by digital computers results from use of magnetic amplifier reel servos and the double-shielded ball bearings used throughout. **Circle 294 on Reader Service Card.**



VTVM
For wideband use

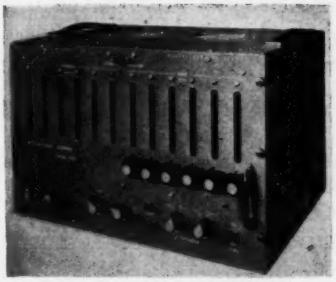
KAY ELECTRIC Co., Maple Ave., Pine Brook, N. J. The Microlter, a new stabilized vtvm without feedback for wideband accuracy to 50 mc is available. The unit employs new stabilizing techniques to supplant the previously used feedback arrangement and overcome its attendant frequency limitations. As a result, the Microlter achieves performance standards at high frequencies hitherto unattainable except by highly complicated combinations of narrow band tuners or by heterodyne techniques.

The Microlter permits the measurements of low-level r-f signals down to 250 μv. Its 7-position switch provides full scale steps of 1, 0.3, 0.1, 0.03, 0.01, 0.003, and 0.001 v to provide an easy-to-read meter scale.

This instrument can also serve as a wideband video amplifier with a maximum output of approximately 0.25 v at 75 ohms and gains of up to 40 db.

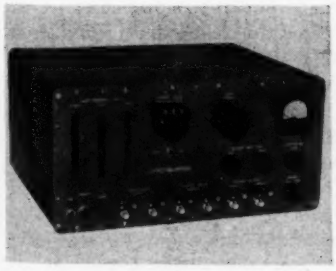
Frequency range is 100 cps to 50

mc. Accuracy is ±10 percent of full scale reading. Frequency response is ±1 db. Voltage range is 1 mv to 1 v full scale in 7 ranges. **Circle 295 on Reader Service Card.**



Integrator
For data reduction

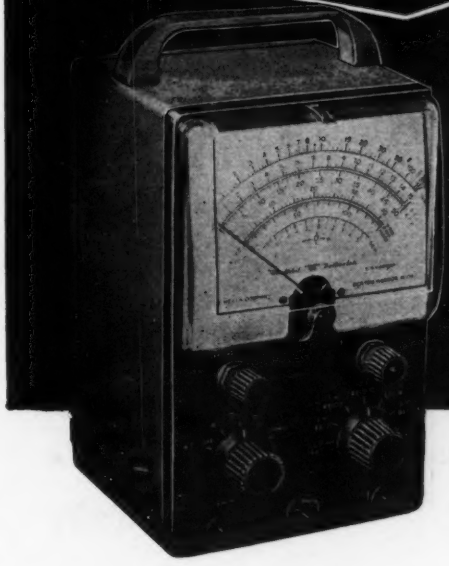
ALLEGANY INSTRUMENT CO., INC., 1091 Wills Mountain, Cumberland, Md. Model 270 integrating system accepts analog voltage signals, digitizes by heterodyne technique, and integrates area under signal curve by counting at rate of 10,000 per sec for high resolution of transient phenomena. Integral can be total area under curve, area above a preselected signal level, or area under curve for a preselected time interval. Both integral and elapsed time are displayed digitally. The instrument provides highly accurate measurements of energy by integrating power vs time, impulse by integrating force vs time. **Circle 296 on Reader Service Card.**



Pulse Timer
For delay measurement

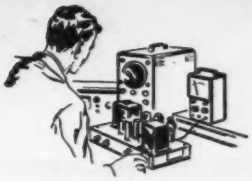
TELETRONICS LABORATORY, INC., 54 Kinkel St., Westbury, L. I., N. Y. Designed primarily for the accurate measurement of delays in

look what $24.50 buys in test equipment!



HEATHKITS GIVE YOU TWICE AS MUCH equipment for every dollar invested

The famous model V-7A Vacuum-Tube-Voltmeter is a perfect example of the high-quality instruments available from Heath at ½ the price you would expect to pay! Complete, only $24.50



Get the most out of your test equipment budget by utilizing HEATHKIT instruments in your laboratory or on your production line. Get high quality equipment, without paying the usual premium price, by dealing directly with the manufacturer, and by letting engineers or technicians assemble Heathkits between rush periods. Comprehensive instructions insure minimum construction time. You'll get more equipment for the same investment, and be able to fill your needs by choosing from the more than 100 different electronic kits by Heath. These are the most popular "do-it-yourself" kits in the world, so why not investigate their possibilities in your particular area of activity! Write for the free Heathkit catalog now!

Contains detailed descriptions of Heathkit models available, including VTVM's, scopes, generators, testers, bridges, power supplies, etc.

FREE catalog
Mail coupon below for your copy—Now!

Also describes Heathkit ham gear and hi-fi equipment in kit form. 100 interesting and profitable "do-it-yourself" projects!

HEATH COMPANY
A SUBSIDIARY OF DAYSTROM, INC.
BENTON HARBOR 14, MICHIGAN

Name _____
Address _____
City & Zone _____
State _____

Fastest
fully automatic
toroidal
coil winder!

World's fastest winding machine with ***automatic core rotation . . .***

. . . produces ***uniform coils*** *automatically*

Winding compact, uniform toroids quickly is no problem with this machine. Boesch TW 200 has an automatic core holder and rotating assembly that eliminates any manual coil handling during winding. The result? Every coil is wound evenly; each toroid is an exact duplicate of the previous design. What's more, this easily-operated machine winds all types of magnet and filar wire including silk, cotton and Teflon or sleeve covered wire . . . operates at fixed or variable speeds . . . produces toroids with .218" ID through 5" OD in AWG #20 through #42. Get full details on the Boesch Automatic Coil Winder and all Boesch machines today. Write for Catalog 57A now.

Boesch Automatic and Semi-Automatic machines feature interchangeable shuttle equipment, easily adapting them to all your winding needs . . . one of many advances pioneered by Boesch.

BOESCH MANUFACTURING COMPANY, INCORPORATED
DANBURY, CONNECTICUT

Comparison is the best test of excellence. See for yourself why Boesch manufactures the world's most superior winding machines.

radar applications this instrument differs from conventional time delay generators in that it uses one pulse chain to produce both fixed and delayed pulse.

Jitter of less than 0.001 μsec is obtained in this design, and delays of up to 10,000 μsec can be measured with an accuracy $\pm$ 0.01 μsec. Time is read directly from a combination of decade counters and digital dial.

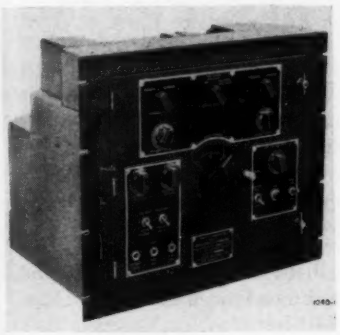
Mechanically the instrument is a full size module of the TLI modular instrumentation system and therefore may be used with the modular system stack pedestal for bench mounting or rack mounted with the modular rack adapter. **Circle 297 on Reader Service Card.**

True Motion Radar For shipborne use

Decca Radar, Inc., London, England. The TM.46 true motion radar displays the radar picture so that the true movements of all vessels, including that of one's own ship, can be easily and unambiguously assessed by inspection of the scope. Unlike the former systems where one's own ship appears continuously at the center of the radar scope and the movement of other echoes is relative, true motion presentation shows one's own ship moving across the display at its correct course and speed and the movement of all other echoes is true.

Advantage of true presentation is that information on other ships' true course and speed is available directly from the radar scope. In

the open sea, particularly when a "close quarters" situation is developing, this information gives the navigator an immediate appreciation of what is really happening in the vicinity of his ship. In close waters the radar picture is similar to that observed at a shore base radar station and even on a complicated situation the movements of all vessels can be readily assessed. **Circle 298 on Reader Service Card.**



Test Generator For VOR equipment

TELECTRO INDUSTRIES CORP., 35-18 37th St., Long Island City 1, N. Y. Model TA-1040 is designed to provide standard signals for accurate testing and calibrating VOR equipment. Standard signals available from the generator are a 30-cps variable-phase signal and two frequency-modulated signals (test and auxiliary). Each of the f-m has a mean frequency of 9,960-cps modulated by a 30-cps sine wave (reference phase signal) having a deviation ratio of 16. With the 9,960-cps signal as center frequency, the swing is ± 480 cps.

Phase relationship between the 30-cps variable-phase signal and the reference-phase f-m signal on the 9,960-cps carrier is continuously adjustable from 0 to 360 deg. This simulates the corresponding VOR course. Adjustments are made by an accurately calibrated dial and vernier arrangement on front panel.

Overall dimensions are 15¾ in. high; 14½ in. deep; 19 in. wide. Total weight including cables is 51 lb. **Circle 299 on Reader Service Card.**

OPERATIONAL AMPLIFIER STABILIZED BY AIRPAX CHOPPER

Wide-Band Directly Coupled Amplifier

Equipments such as operational amplifiers in large-scale analog computers and controllers and in wide-band instruments like oscilloscopes require

wide-band (rapid) response,
highly stable null, and
low zero offset.

These characteristics are achieved by using Airpax Type 175 choppers in amplifiers built by George A. Philbrick Researches, Inc., Boston 10, Massachusetts.

A conventional operational amplifier provides wide-band response. A chopper stabilizing amplifier connected in tandem with this amplifier counteracts any tendency for the null to drift from zero. Selected or matched components are unnecessary in the stabilizing amplifier; with the mechanical modulator, no manual null adjustment is necessary. When stabilized in this manner, the drift of the operational amplifier is typically less than 100 microvolts.

CHARACTERISTICS OF TYPE 175 CHOPPER

Airpax 60-CPS chopper Type 175 is a miniature unit with permanently adjusted SPDT BBM contacts.

DRIVE

Frequency .. 60 ±3 CPS
Voltage .... 6.3 ±0.6 RMS volts

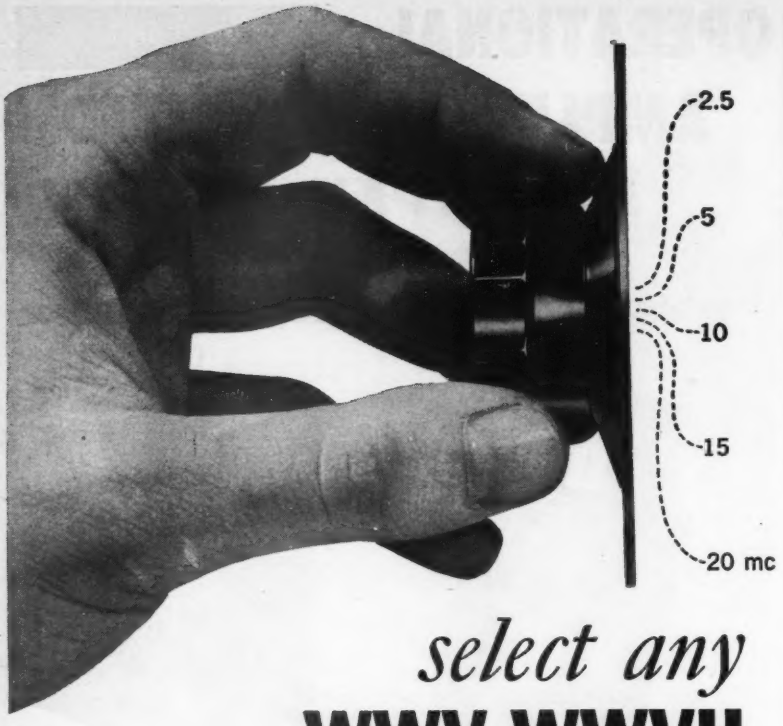
CONTACTS

Dwell Time . 167 ±10 electrical deg.
Balance .... within 15 electrical deg.
Phase Angle 20 ±5 electrical deg.
Voltage .... up to 100 DC volts
Current .... up to 2 MA
Noise ..... 50 microvolts average

Hermetically sealed for trouble-free operation in any atmosphere; internal mechanism rigidly mounted to withstand shock and vibration encountered in portable and laboratory equipment.

Airpax Products Co., Cambridge Division, Jacktown Rd., Cambridge, Maryland

AIRPAX
DESIGNERS ENGINEERS



select any
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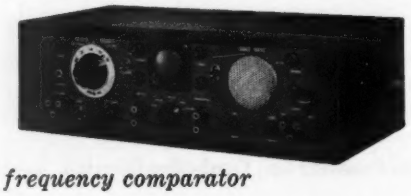
MODEL WWVC FREQUENCY COMPARATOR ENDS "SEARCHING" FOR THE STRONGEST STANDARD SIGNAL

This new tool can save you valuable calibration time. With it you can quickly find the strongest signal available at any moment from the National Bureau of Standards – *without searching.*

A five-position dial switches precisely to any standard frequency – 2.5, 5, 10, 15 or 20 MC – each crystal controlled. Built-in oscilloscope and speaker make measurements easy. Model WWVC includes comparator function selector, Collins plug-in filter for high selectivity, automatic gain and volume controls, and adjustable threshold control which eliminates noise and other modulation in tick position. Calibrate any frequency *accurately* and *quickly* with the Model WWVC. Write for Bulletin C-1.



MODEL WWVC *standard frequency comparator*

SPECIFIC PRODUCTS

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New Literature

MATERIALS

Copper Foil. The American Brass Co., 75 Liberty St., Ansonia, Conn., has released an 8-page illustrated booklet suggesting commercial applications of copper foil. Its electrical applications, such as electrostatic shielding and printed circuitry, are included. **Circle 351 on Reader Service Card.**

Custom Molded Teflon. Sparta Mfg. Co., Dover, Ohio, has published a 4-page brochure covering their patented process of custom molding parts of Teflon in thin sections and shapes. **Circle 352 on Reader Service Card.**

Plastic Molding Compound. Technion Design & Mfg. Co., Inc., 262 Mott St., New York 12, N. Y. Bulletin 113 describes Speedi-set plastic molding compound, a new single component thermosetting flexible plastic used in making molds for casting cold setting ceramics and plastics. **Circle 353 on Reader Service Card.**

COMPONENTS

AN Connectors. Hermetic Seal Corp., 29 South Sixth St., Newark 7, N. J. A simplified guide for selecting and specifying hermetic seal glass-to-metal AN connectors for military and commercial applications is contained in a 16-page catalog, No. 657 C. **Circle 354 on Reader Service Card.**

Carbon Pile Rheostat Elements. Speer Carbon Co., St. Mary's, Pa. A wide range of carbon disks, plates and pile assemblies for all types of carbon pile rheostats and similar control units are discussed in a five-page bulletin, No. 6AE, now offered. **Circle 355 on Reader Service Card.**

Germanium Component Rectifiers. General Electric Co., Schenectady 5, N. Y. Bulletin GEA-

of the Week

5773C, six pages, tells how to select and apply fan-cooled and blower-cooled germanium rectifiers. Tables, charts, line drawings and photographs are included. **Circle 356 on Reader Service Card.**

Hook-Up Wire Kits. Birnbach Radio Co., Inc., 145 Hudson St., New York 13, N. Y. Bulletin TK-120 covers Teflon hook-up wire kits. The kits described offer ideal variety of sizes and colors for the design and research engineer. **Circle 357 on Reader Service Card.**

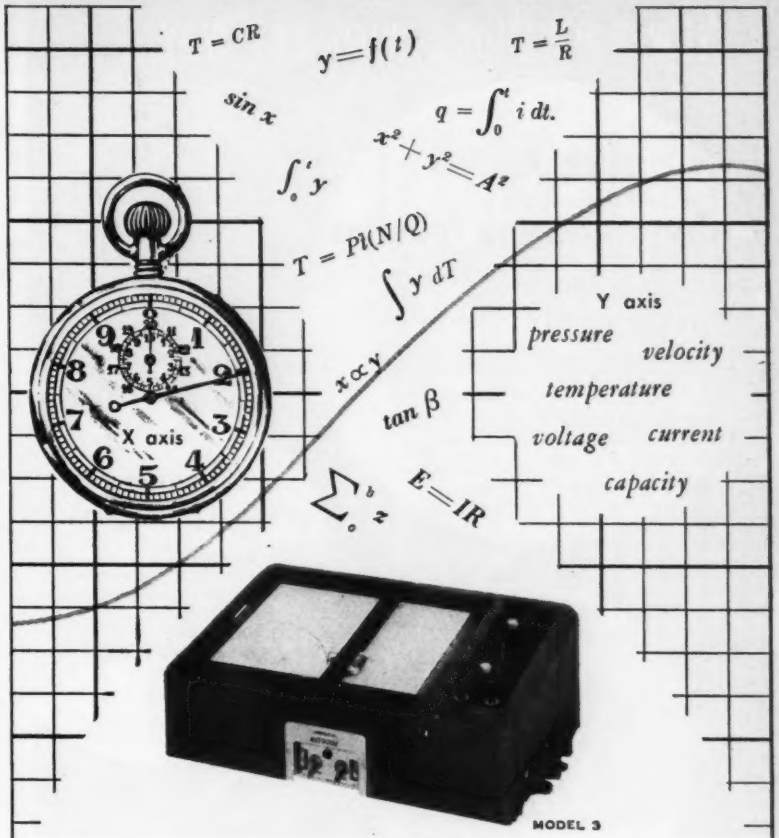
Magnetic Shields. Magnetic Shield Division, Perfection Mica Co., 1322 N. Elston Ave., Chicago 22, Ill. Data sheet 132 deals with Co-Netic low level magnetic shields which fit all 7 and 9 pin tubes and which eliminate magnetic interference and prevent magnetic hum in fields of 25 gauss or less. **Circle 358 on Reader Service Card.**

Printed Circuits. Sprague Electric Co., North Adams, Mass. Technical Paper No. 57-3 contains a comprehensive guide to the application and design of Bulplate ceramic printed circuits. **Circle 359 on Reader Service Card.**

Reliable Controls. The Hart Manufacturing Co., 110 Bartholomew Ave., Hartford, Conn., has published a new checklist of reliable controls containing capsule information about the complete line of "Diamond H" relays, thermostats, rotary switches, range switches, motor controls and "snap-ins." **Circle 360 on Reader Service Card.**

R-F Chokes. NYT Electronics, Inc., 2979 N. Ontario St., Burbank, Calif. Bulletin 125 describes 125 C encapsulated chokes. The units discussed meet performance requirements of MIL-C-15305A, Grade 1, Class B. **Circle 361 on Reader Service Card.**

Silicon Switching Diode. Shockley Semiconductor Laboratory,



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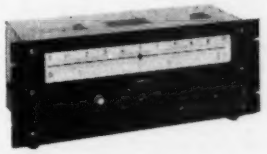

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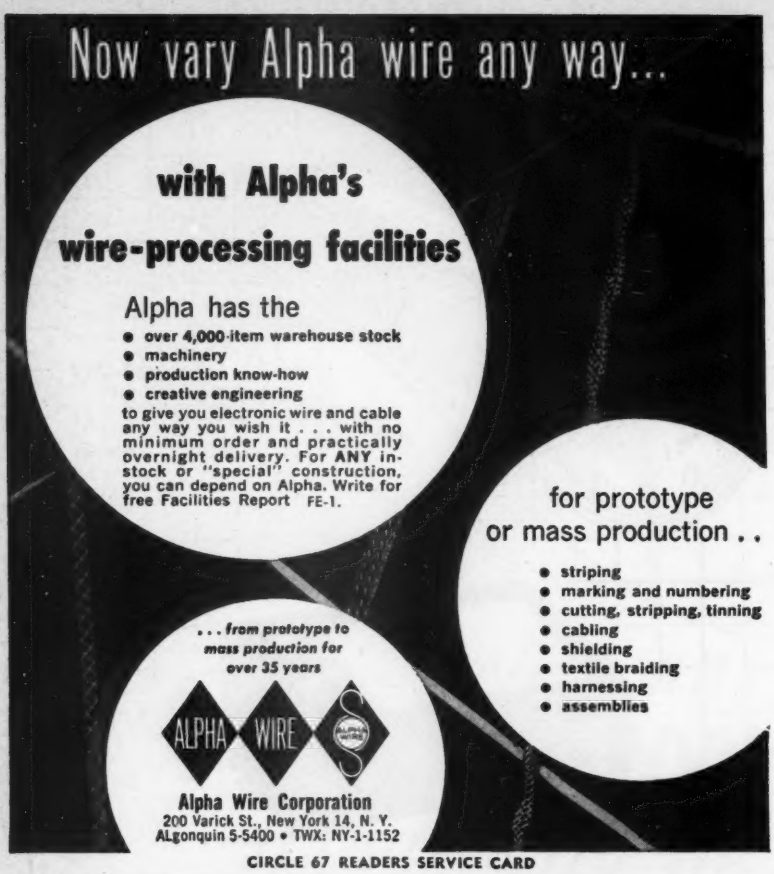
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Beckman Instruments, Inc., Mountain View, Calif. Recommended for application in sawtooth oscillators, pulse generators, bistable circuits, ring counters, and various switching circuits, the Shockley 4-layer *npnp* silicon diode is discussed in a 4-page folder. **Circle 362 on Reader Service Card.**

Transistor Specification Chart. Industro Transistor Corp., 649 Broadway, New York 12, N. Y., has published a specification chart for its line of transistors. Included in the chart is an interchangeability guide, enabling one to tell at a glance which particular Industro types may be interchanged for other standard transistor types. **Circle 363 on Reader Service Card.**

Wire-Wound Resistors. RCL Mfg. Co., New Jersey Ave., Riverside, N. J. A 12-page illustrated folder gives selection data, ordering instructions, description and specifications for a line of precision wire-wound resistors. **Circle 364 on Reader Service Card.**

EQUIPMENT

A-C Ratiometer. Transformers, Inc., 200 Stage Road, Vestal, N. Y. Bulletin 204 gives uses, features, general description and specifications of the a-c ratiometer which is accurate to five parts per million. **Circle 365 on Reader Service Card.**

Airborne TV Transmission System. Electronics Development Co., Inc., 3743 No. Cahuenga Blvd., No. Hollywood, Calif. Specification sheets on the TX-108 airborne tv transmission system are available. **Circle 366 on Reader Service Card.**

Continuous Resistance Winder. Geo. Stevens Mfg. Co., Pulaski Rd. at Peterson, Chicago 30, Ill. A recent catalog page gives full technical details on model 209 fully automatic continuous resistance winder. **Circle 367 on Reader Service Card.**

Edge Register Detector. Post Machinery Co., Beverly, Mass.

Model ER-1, designed especially to control materials manufactured or processed in a web form, is described and illustrated in a 2-page bulletin. Technical specifications are given. **Circle 368 on Reader Service Card.**

Industrial Electronics. Robotron Corp., 21300 W. Eight Mile Road, Detroit 19, Mich. New ideas in electronics controls for industry are shown in a 12-page bulletin "Industrial Electronics for You." **Circle 369 on Reader Service Card.**

Numerical Data Printers. Clary Corp., 408 Junipero St., San Gabriel, Calif. Literature describing new stock models of parallel entry numerical data printers for computers, production testing, data-reduction systems, and the like, is now available. **Circle 370 on Reader Service Card.**

Scientific Instruments. Eldorado Electronics Co., 2821 Tenth St., Berkeley, Calif., has released a new short form catalog. Four instruments of special interest to the electronic scientist and physicist are briefly described and specified. **Circle 371 on Reader Service Card.**

Transistor Inverters. Varo Mfg. Co., Inc., 2201 Walnut St., Gardland, Texas, has prepared a booklet on its transistor inverters for conversion of d-c power to precision 400 cps a-c power. **Circle 372 on Reader Service Card.**

FACILITIES

Flux-Dip Brazing. Waveline Inc., Caldwell, N. J., announces a 4-page report on aluminum flux-dip brazing of waveguide and other electronic assemblies. Advantages of the process are listed. **Circle 373 on Reader Service Card.**

Infrared Reconnaissance. Engineering & Optical Division of the Perkin-Elmer Corp., Main Ave., Norwalk, Conn. A 12-page brochure describes what infrared is, its role in aerial reconnaissance, its advantages, and how it can be used in conjunction with radar. **Circle 374 on Reader Service Card.**

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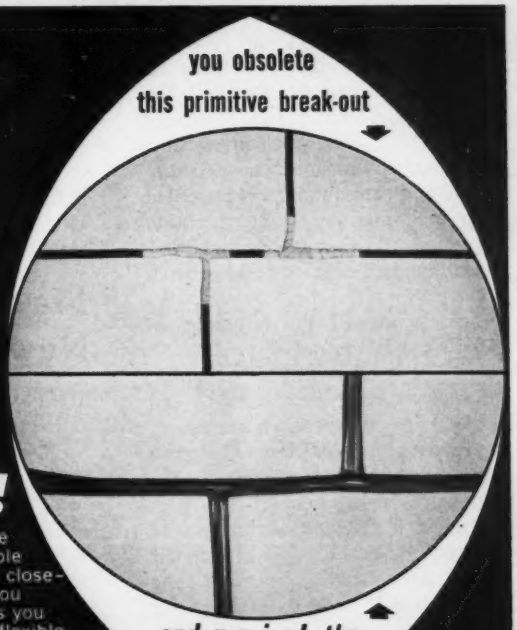

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WU Honors Pioneers

WESTERN Union recently honored two of its pioneer engineers for inventions in the field of f-m carrier telegraphy.

The 1957 d'Humy medal—awarded periodically for significant contributions in the telegraph art—went to F. Beaumont Bramhall (at left in the picture) and J. Edwin Boughtwood (right) for their research and basic inventions in the use of f-m carrier in commercial telegraphy. Three-inch bronze medallion, accompanied by a certificate and cash award, was presented to each man by Western Union president Walter P. Marshall. Several hundred engineers and research people from the company and other firms witnessed the ceremony in WU's auditorium.

"The development of f-m carrier, which brought new stability and speed to telegraph transmission, was a monumental forward step in the progress of record communications," Marshall said.

He pointed out that three out of every four miles of WU's circuit capacity are carrier operated. The total of 3,370,346 miles of carrier circuits is enough to cross and recross the continent 1,300 times.

"Carrier equipment," Marshall added, "creates a large number of separate telegraph channels of superior dependability from a trunking facility such as a radio beam. This makes it unnecessary to construct millions of miles of additional wire plant."

The award was made to Boughtwood for "fundamental scientific explorations and basic inventions in the field." Bramhall received his award for "contributions to the art of f-m carrier telecommunication, and for technical direction leading to its wide adoption."

The d'Humy medal was established in 1956 by Western Union in recognition and commemoration of the achievements of the late Fernand d'Humy, at one time a WU vice president and director.

Stavid Opens New Plant

MANUFACTURING operations of Stavid Engineering Inc., Plainfield, N. J., move into a new 65,000-sq ft building designed for the production of missile guidance systems, radar equipment and allied electronic systems. New manufacturing building, next to the firm's administrative and development headquarters, ups total plant space to 160,000 sq. ft.

Expansion results from increases in Stavid's government business. Recent intra-company shift of emphasis advances the firm from a strictly R&D outfit to one whose research and manufacturing activities are about equally divided.

There's method behind Stavid's moves: Defense Department trends indicate more contracts for firms that can both develop and produce electronic gear.

GE Promotes Two Engineers

GENERAL Electric's light military electronic equipment department gets two new engineer-managers as Jack W. Giles and William H. Roadstrum move up.

Giles takes over as manager of the newly formed electronic countermeasures systems engineering subsection. Roadstrum heads the new missiles systems engineering subsection.

Establishment of the two subsections reflects an increasing need for engineering specialization for continuous development and production of airborne electronic equipment and systems.

Epsco Sets Up Systems Group

BOSTON'S Epsco Inc. is forming a new advanced systems design group. The group will be responsible for analyzing customers' systems requirements, working out economical approaches consistent with reliability, accuracy and other performance specifications.

The new setup will comprise some of Epsco's senior engineers. Senior product analyst will be Bruce K. Smith, one of the design engineers on such computer projects as the USAF's FLAC and Remington Rand's Univac Magnetic Computer. Senior field engineer is John N. Cullen, who provides strong background in instrumentation to the group.

A third key member is Eli Anfenger, whose background is in computer linkage equipment and in the design of the Addaverter, a multichannel computer link recently placed in operation on the west coast.

Rounding out the group is Irwin M. Stone, senior applications engineer with broad experience in high-

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This Twinplex communication system makes possible a 2-channel radio circuit whereby 2 non-synchronous or synchronous telegraph transmissions modulate a single radio carrier wave by causing the carrier to assume one of four specific frequencies with 400 cps separations.

The transmitting equipment consists of the Twinplex Combiner Type 177 Model 1 and an RF Frequency Shift Keyer such as the Northern Radio Type 105 Model 4. The Combiner converts the four possible conditions of two telegraph signals (M1-M2, M1-S2, S1-M2, S1-S2) respectively into one of four voltages related in a 0-1-2-3 manner. The Combiner output voltage modulates the FS Keyer.

The receiving equipment consists of the Twinplex Converter Type 178 Model 1 and a single or diversity receiver such as the Northern Radio Type 110 Dual Diversity Receiving System. The Converter demodulates and separates the four audio tones from the radio receiver(s) into two channels each carrying the originally transmitted intelligence. The Twinplex Converter replaces the standard FS Converter for this purpose.

The two telegraph channels provide the same operational flexibility as that of two separate single channel FS systems. One can, for example, simultaneously use channel #1 on 60 wpm teletype and channel #2 on high-speed Morse or Time Division Multiplex. It further permits the reception of channel #1 signals on all standard FS converters (tunable to 400 cps shift) without need for a Twinplex Converter: this is valuable for "Forked Circuit Operation" where the intelligence of channel #1 is intended for pick-up by other receiving stations which are not equipped for Twinplex Reception in addition to the main receiving stations which are so equipped. Reception of channel #2 (or of both channels) requires the receiving end to be equipped with a Twinplex Converter.

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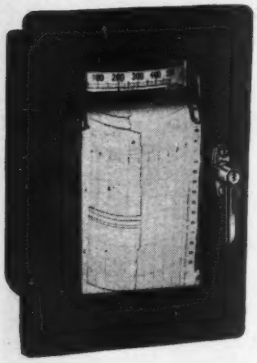

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speed analog-to-digital conversion devices and data-acquisition systems.

Meanwhile, Epsco hires Danforth W. Comins away from Cambridge Thermionic Corp., moves him in as general manager of the components division.

Eldorado Adds to Tech Staff

JUMPING feet-first into the nuclear instrument field, Eldorado Electronics Co., Oakland, Calif., appoints Zoltan Tarczy-Hornoch (picture) as senior staff member of the engineering department.

Tarczy-Hornoch will direct expansion of the firm's products in areas of ultrahigh-speed nuclear spectrometry, scaling and time-measuring instrument systems for nuclear research.

The Hungarian scientist was once associated with the Central Research Institute for Physics in Budapest, as chief engineer of the electronics research laboratory.

Philco Ups Researchers

APPOINTMENT of William H. Forster as director of research for the newly formed solid state electronics department of Philco's research division has been announced.

Carlo V. Bocciarelli was moved

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up as assistant director of research for the department, reporting to Forster.

Forster has been associated with Philco's research and development activities since 1943. Last year he was named associate director of semiconductor research.

Philco also moved Allen C. Munster up to the post of associate director of research. He will work with James F. Koehler, who directs the research activities of the firm's government and industrial department.

IERC Sets Up Two Divisions

In Burbank, Calif., International Electronic Research Corp. expands into the aviation instrument and equipment fields. Two recently announced subsidiaries, to be operated as IERC divisions, are Electronics International, Burbank, and Aircraft Electronics, Long Beach.

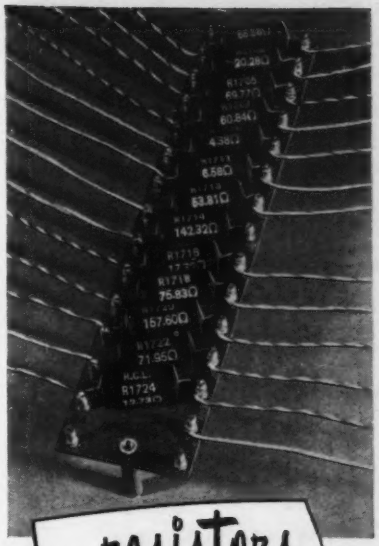
Electronics International will operate as a special products division, will produce precision power oscillators. The oscillator business follows IERC's acquisition of proprietary rights formerly owned by Pasadena's Neucor Corp.

Aircraft Electronics aims to provide private and executive aircraft with installation, modification and repair services for electronic equipment. The division will sell and service major brands of communications navigation radar and other electronic gear.

Haydu Adds to Present Plant

Facilities of Haydu Electronic Products Inc., Plainfield, N. J., are being increased by some 15,000 sq ft to meet growing demands for precision instruments. Haydu also plans to increase its staff of engineering, production and technical people.

The company is at present organized into three operating divisions. Precision products and aircraft accessories division manufactures components used in computers,



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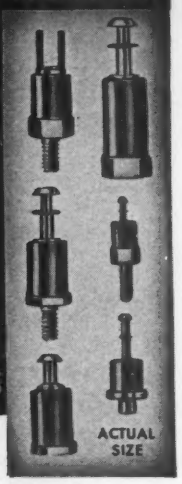

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guided missiles, electron tubes and other assemblies. Instrument division overhauls and repairs gyros, tachometers, indicators and similar airborne gear. Industrial gas burner division supplies burner equipment for the glass-working industry's use in making electron tubes.

Plastoid Gets Tech Director

NEW technical director for Plastoid Corp., Hamburg, N. J., is Leon Brodsky. He takes charge of design, R&D and quality control activities for the firm.

Brodsky was formerly with IT&T's Federal Telephone & Radio Co. in Clifton, N. J. From 1949 until his recent move he was chief engineer of Federal's wire and cable component division.

DuMont Shuffles Tube Divisions

MAJOR step toward realigning functions of the television tube division and the industrial tube division at Allen B. DuMont Laboratories comes with the appointment of two engineers to newly created posts. The jobs were created to coordinate the efforts of the two divisions.

Robert E. Rutherford Sr. and Kenneth F. Hoagland have been named staff assistant and director of engineering respectively. Their new responsibilities include both divisions.

Prior to their new appointments, each was an engineering manager of one of the divisions, Rutherford of industrial tube and Hoagland of the tv tube division.

RFL Expands

PRODUCTION assembly operations of Radio Frequency Laboratories' test and service products and communications products divisions are moving into new quarters. New production building provides three times the floor space previously occupied. Space vacated in the move

need high vacuum components?

Stokes Vacuum Gauges are compact electrical instruments for accurately measuring very low absolute pressure. They are available for indicating or recording. Three models cover the ranges of 100, 1000 and 20,000 microns. Measurements are continuous and consistently accurate—response is virtually instantaneous. Stable calibration is assured by use of noble metal thermopiles operating at low temperatures. Stokes Vacuum Gauges operate on 115 volts, 60 cycles—are mounted in small, lightweight metal cases.

STOKES makes a complete line of vacuum components . . . advance-designed and engineered to help make your vacuum systems more productive. Each unit reflects Stokes' unparalleled experience, pioneering leadership and wealth of basic vacuum technology.

The product list includes: Diffusion Pumps, Vapor Booster Pumps, Mechanical Pumps, Mechanical Booster Pumps, Vacuum Gauges, and Valves.

Send for technical data on any or all . . . without obligation.

High Vacuum Division
F. J. STOKES CORP.
5560 Tabor Road, Phila. 20, Pa.

STOKES

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is now devoted to stockroom and materials inspection.

New facilities relieve congestion resulting from increased sales activities, provide space for future expansion.

Plant space now totals 44,000 sq ft on a 14-acre site in Boonton, N. J. RFL employs 165 people.

Farnsworth Lab Gets New Chief

FARNSWORTH Electronics Co. hires Donald K. Coles to head up its solid state laboratory.

Coles comes to the IT&T division after fifteen years at Westinghouse Research Laboratories. While at WRL he pioneered in infrared and microwave spectroscopy, worked on applying solid-state principles to industrial products.

New V-p for Canalco

CANAL Industrial Corp., Bethesda, Md., hires Lee D. Cochran away from RCA, makes him vice president for research and production. Cochran, who specialized in electron microscopy at RCA, will direct an expansion program for the Maryland instrument maker.

New instrumentation program will explore electron and X-ray microscopy and analysis, gas analysis and processing, freeze-drying and other low-temperature processes. New equipment to emerge this year will have industrial applications in research and production, biological applications of both a research and a clinical nature.

Auerbach Hires Two

TECHNICAL staff of Auerbach Electronics, Narberth, Pa., grows with the addition of two longtime professional associates of the firm's chief.

I. L. Auerbach, who left Bur-

This miniature NU Cathode-Ray TUBE

CAN PRODUCE 900 DOTS IN THIS AREA

900 DEFINITE BITS OF INFORMATION IN A SPOT SIZE OF ½" x ½"

A visual monitor for readouts, film recordings, indicators and instrumentation. Electrostatically focused and deflected in a T6½ bulb with 9-pin miniature tipless base. Good light output. Withstands standard shock and vibration tests. Available in all commercial phosphors.

A1 VOLTAGE 150-250v
A2 VOLTAGE 600-1000v
HEATER VOLTAGE (AC or DC).....6.3v

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Developers and Manufacturers of Special Purpose Electron Tubes
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SEMI-CONDUCTOR ENGINEERS & PHYSICISTS

1958 is going to be another big year in our progress and we need you to help us grow. At present we rank 6th in the industry and we have the technical leadership, youth, drive and desire to rank 1st in this dynamic industry. We would like to hear from men with the following backgrounds:

METALLURGICAL ENGINEERS
DEVICE DEVELOPMENT PHYSICISTS
SEMI-CONDUCTOR PROCESS ENGINEERS
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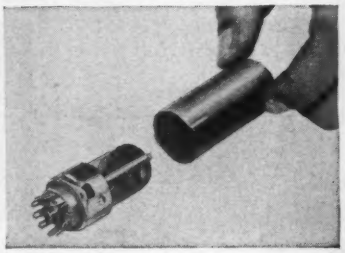
Direct Mail is a necessary supplement to a well rounded Business Paper advertising program.
Most progressive companies allocate a portion of their ad budgets to this second medium at the same time as they concentrate on the best business publications.
600,000 of the top buying influences in the fields covered by the McGraw-Hill publications make up our 150 mailing lists. Pick Your prospects out of our Industrial Direct Mail catalogue.

Write for your free copy. It contains complete information.

7 & 9 PIN TUBE CO-NETIC MAGNETIC SHIELDS

For Fields Under 25 Gauss



Fits all 7 & 9 pin vacuum tube socket assemblies with bayonet type flange. Prevents virtually all outside magnetic interference from entering the tube and prevents magnetic hum in fields 25 gauss and less. (If your problem involves higher intensities, send complete details).

Shields are insensitive to shock. Shielding qualities not affected when Co-Netic is worked or transported. There is negligible residual magnetism. No periodic annealing required. Available in sizes ⅞" up to 5" ID in round, square or rectangular shapes to your specification. No tool charge on many sizes and shapes. Special designs can be made to your drawing.

Also available for other applications: New 3-layer economical rotary drawn Netic Co-Netic magnetic shielding cans. New rotary drawn process eliminates substantial tool charges formerly necessary making it possible to encase components containing moving or stationary permanent magnets without distorting their magnetic field or otherwise reducing their sensitivity.

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Now! Fernetic and Co-Netic can be furnished tinned, ready for soldering — without affecting shielding qualities.

ELECTRONIC ENGINEER RESEARCH

The Research Division of Curtiss-Wright Corporation has expanded its activities to include the fields of Electronics and Ultrasonics. The Research Division, which offers the atmosphere of a small organization conducive to research, has new facilities located in the picturesque mountain area of Northwestern Pennsylvania approximately twenty miles north of Clearfield. Permanent positions are available for individuals at all levels, with two or more years of experience in electronic circuit design. Although advanced degrees are desirable, applicable experience with analytical ability in the fields of Ultrasonics, Navigation Devices, Communications, Weapon Systems, Simulators, Computation and Data Handling Systems will suffice.

Excellent salary, Executive Benefits and Family Security Programs. Send typewritten resume giving details of education, past experience and current earnings to:

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Curtiss-Wright Corporation, Wood-Ridge, N. J.

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roughs Corp. to start up his own company, now adds Paul Winsor III and Arnold B. Shafritz to his engineer complement.

Winsor, who will head the systems engineering staff, was formerly manager of systems analysis department at Burroughs Research Center in nearby Paoli, Pa. Before that, Auerbach and Winsor knew each other's work at Eckert-Mauchly Computer Corp., later to become a division of Remington Rand.

Shafritz assumes responsibility for industrial product development at Auerbach Electronics. He, too, is a graduate of Burroughs Research Center, where he supervised the logical design and programming section. Before that he worked with air flight-control and fire-control systems at the Naval Air Development Center and at Frankford Arsenal.

United Control Plans Big Plant

UNITED Control Corp. has cleared the site for a $1.5-million plant at Bellevue, near Seattle, Wash. The plant will have 100,000 sq ft of floor space, may ultimately grow to 350,000 sq ft. Plans now call for occupancy of the new site by 1960.

United now has more than 500 employees in five plants grouped in Seattle's University district. It makes electronic controls for aircraft and missiles.

Allis-Chalmers Moves Four

INDUSTRIES Group of Allis-Chalmers has shuffled four managers in its Mid-Atlantic region.

C. W. Parker Jr., manager of the Richmond district since 1955, moves up to take over the Philadelphia district. He succeeds A. D. Brown, who has been transferred to the office staff of the Mid-Atlantic region.

J. M. Mathews succeeds Parker as manager of the Richmond district. He had managed the Charleston district since 1948. Baltimore

Pulse Notes

Advantages of Air Gap vs. Toroidal Construction in Pulse Transformers

As pointed out in previous Pulse Notes, a pulse transformer wound on a core with an accurately controlled air gap performs more satisfactorily in some applications than one wound on a toroidal (gapless) core.

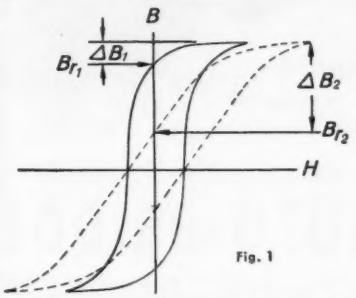

Fig. 1

Consider for a moment the two B-H loops in Figure 1. The loop shown in solid lines is for a toroidal sample of a typical magnetic material used in pulse transformers. The dashed loop is for the same material with an air gap included in the magnetic circuit. In the case of the toroid, removing the pulse magnetizing force causes the core flux to return to the value Br_1*. On the next pulse the total flux swing possible is $\triangle B_1$.

The gapped core, on the other hand, returns to Br_2 which allows the much greater flux swing $\triangle B_2$. Consideration of the voltage-time integral, $ET = NA\int dB$, indicates that a pulse transformer wound on the gapped core passes a pulse of greater area without core saturation than one wound on the gapless or toroidal core.

*This discussion is valid only for cases in which no reverse (resetting) current flows in any of the transformer windings.

For further technical information including diagrams, specifications, and schematic applications of pulse transformers, write for your free copy of our new 12-page catalog.

4

Pulse Engineering Inc.

2657 Spring Street
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CALIFORNIA

sales rep Gordon Hood moves down to take over the Charleston district succeeding Mathews.

Cubic Corp. Buys Digital

Acquisition of Digital Inc., San Diego, Calif., manufacturer of digital instruments, has been announced by Cubic Corp.

Cubic feels that Digital's products will fill out its own line of proprietary hardware, provide a basis for further development in instrumentation and automatic control.

Cubic makes transistorized test instruments, calorimetric wattmeters and power measuring gear. Some of its test equipment is used in USAF missile programs.

Sam Levy, v-p of Digital, moves over to join Cubic's staff.

Vacation-Spot Firm Expands

Desert Hot Springs, Calif., chiefly renowned as a vacation spot, is watching its only manufacturing facility double in size. The San Gorcinto plant of Assembly Products Inc. is expanding in the desert sun.

Bradley R. Thompson, board chairman of the firm and manager of the plant, feels that his plant is the forerunner of a small local boom in electronics and other light industry, similar to the growth of industrial centers in Phoenix and Tucson and at Log Angeles itself. At the moment, the API plant is the only electronics manufacturing establishment in the desert area east of Riverside, Calif.

Founded by Thompson in Ohio in 1945, Assembly Products teetered for seven years on the verge of bankruptcy. When it began to write its books in black, its founder looked all over the southwest for another place to live and work.

In late 1955, Thompson built the desert plant and started to make high-sensitivity meter relays, an offshoot of his original work in Ohio.

When the Desert Hot Springs

MULTICYCLE MODEL 281-B VARIABLE FREQUENCY SUPPLY

This unit has been designed for production line testing of equipment operating in the 250 cycle to 1000 cycle range. It is a bench type unit, entirely self-contained, operating from standard 115 volts, 60 cycle power. The model 281-B supply consists of a sine wave audio oscillator driving a class AB1 beam power amplifier, followed by stabilizing and voltage control networks. Since no grid current is drawn, low distortion is achieved throughout the entire power range without resorting to expensive components and networks. The power amplifier tubes have a plate dissipation rating of 100 watts, permitting operation into practically any load, regardless of power factor, within maximum volt-ampere rating. Frequency may be varied over a wide range by a single screwdriver adjustment.

Frequency Range: 250 cycles to 1000 cycles, continuously variable.
Distortion: Less than 5%.
Voltage Regulation: 3% from no load to full load.
Power Input: 115 volts, 60 cycles, full load power 230 W.
Power Output: 100 VA, 100 W, 1 PF.
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- **NO CONTAMINANTS** . . . snow-white color.
- **ALL SIZES** of rod from ⅛" to 2" . . . to the nearest 0.001" at no extra cost. Sizes over 2" can be supplied in molded rod.
- **ANY LENGTH** . . . normally supplied in 12-foot lengths, but we'll ship it any length you say.
- **ALL PRODUCTS FOR ELECTRONICS INDUSTRY** made from virgin "Teflon" . . . meet AMS 3651B and MIL-C-17B specifications.
- **IMMEDIATE DELIVERY** on all sizes.

Chemplast also supplies tape, tubes, and sheets of "Teflon" . . . and wire coated with "Teflon." Write today for a prompt quotation.

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plant opened, Thompson was lucky to find one experienced man, Richard Bond, who had worked at Assembly Products in Ohio. Bond had previously moved to California for the sake of his wife's health and his own. When he heard that Thompson was building the California plant, he joined up. Now he is plant superintendent.

Between them, Thompson and Bond trained local employees—mostly green as grass—in the precision work. Most of the people who came to work and learn didn't know what a meter movement was. One young man's background was selling shoes and carpentering in Detroit. Another had been an auto mechanic. One of the best employees Thompson has was once a bartender in Needles, Calif.

IT&T Sets Up Canada Firm

In Montreal, International Telephone & Telegraph has organized a new subsidiary. The firm, Electronics Service Co. of Canada Ltd., will offer a wide range of services. It will operate and maintain telecommunication and electronic equipment, such as microwave links and radar networks. It will also engineer such installations and evaluate alternative systems. Head of the new company is IT&T oldtimer J. T. Robertson.

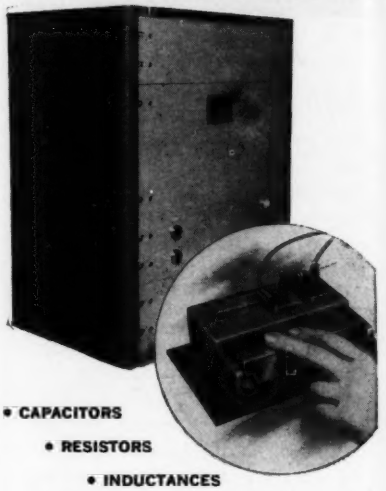
IT&T president Edmond Leavey points out that the DEW line—maintained by another IT&T subsidiary—hires 85 percent of its staff locally. The new subsidiary will give Canadians the chance to employ acquired talents profitably when their time on the DEW line expires.

Clary Combines Two Divisions

In San Gabriel, Calif., Clary Corporation consolidates its Aircraft and Automatic Controls divisions into a single unit called Clary Dynamics.

Clary v-p Paul J. Meeks will be

HIGH SPEED TESTING...



- CAPACITORS
- RESISTORS
- INDUCTANCES

Manual-Feed — Manual-Sort

AUTO-BRIDGE

The newest addition to Industrial Instruments Auto-Bridge line of automatic and semi-automatic test equipment is the Model AB-3X2, manual-feed, manual-sort bridge. Fully automatic hopper or tape-fed equipments have a definite place in component testing, but they are not the most efficient system whereby a large variety of small and medium-size lots of components can be tested.

The Model AB-3X2 is manually loaded and unloaded. One of the two colored lights indicates whether the component under test is "in" or "out" of preset tolerance. Plug-ins are used to set the "high" and the "low" limits and the standard jig supplied with the equipment accepts most wire lead components. There are no meters to read . . . the only interpretation required by the operator is to determine which of the two colored lights is lit. A true limit bridge principle is used. There is no drift in the operating point and daily calibrations are not necessary.

TABLE OF SPECIFICATIONS

	RANGE	ACCURACY	PRODUCTION RATE
Capacity	100 uuf to 15 uf lower at reduced accuracy	±0.3%	Depending on type of feed 7500 electrical tests per hour. Many components can be fed with an overall rate of 5000 per hour
Resistance	10 ohms to 5 megohms, higher at reduced accuracy	±0.3%	
Impedance	10 ohms to 5 megohms, higher at reduced accuracy	±0.3%	

For complete details on this economical Auto-Bridge as well as our full line of associated equipment, write . . .

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general manager of the new division, which will develop and manufacture aircraft and guided missile components. Brian Sparks will be assistant general manager.

The Aircraft division makes pressure regulators and valves for aircraft. Automatic Controls makes gyroscopes, servoactuators and other control components.

Clary officials believe that combined design and production facilities will permit the firm to increase the speed and efficiency of its services to aircraft and electronics industries.

Beckman Hikes Sterne

APPOINTMENT of Karl E. Sterne as sales manager of analog computers for the Berkeley Division of Beckman Instruments, Inc., is announced.

Formerly a Beckman Berkeley applications engineer, Sterne spent two years as a development engineer with the University of California's Radiation Laboratory at Berkeley. Earlier, he was eastern district manager for the Andrew Corp. of Chicago.

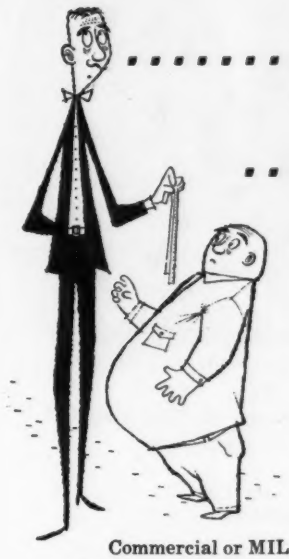
UMAA Elects Bagno to Board

NEW member of the board of directors of the Ultrasonic Manufacturers' Association of America is Samuel M. Bagno. He will serve in this capacity for a 3-year term.

Bagno is chief engineer at the Ultrasonic Division of Walter Kidde & Co., Inc., Belleville, N. J., and has been responsible for many of the developmental projects being carried on by that division.

Mallory Gets Milli-Switch

ACQUISITION of plant facilities and majority interest of the Milli-Switch Corp. of Santa Monica,



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A NEW CRYSTAL UNIT WITH EXCEPTIONAL STABILITY AND PRECISION IN RANGE 4 kc TO 3000 kc

RANGE	A	B
4-85 kc	2"	2⅜"
85-150 kc	1⁹⁄₁₆"	1¹³⁄₁₆"
150-3000 kc	1⅛"	1½"

This all-glass vacuum mounted crystal unit provides maximum stability, with low effective series resistance, in the range between 4 kc and 3000 kc.

For example, in the range 800 kc to 3000 kc, stability of 4 parts in 100 million (4×10^{-8}) per day can be obtained when used with temperature control that holds ±0.1°C. Under these conditions ageing will not exceed 2 parts in 100 million per day.

Supplied for oven or non-oven operation.

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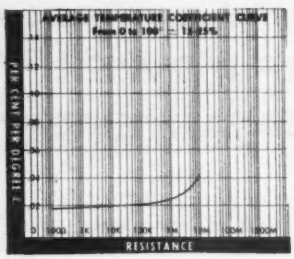
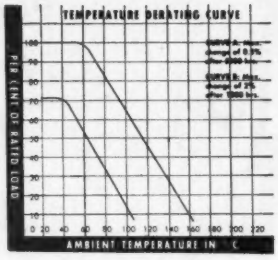
PRECISION CARBON DEPOSITED RESISTORS



Temperature coefficient characteristics for ALPT—1 watt resistor



Derating curve for ALPT—1 watt resistor

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Trio's new **general-purpose** flexible-design Vacuum Tube Volt-Ohmmeter meets MIL specs, has greater sensitivity than conventional units, **maintains 3% AC & DC accuracy over extended temperature ranges,** has high versatility and dependability in small size (8" x 5½").
Flexible design enables economical tailoring to your special requirements: special scale plates, auxiliary go/no-go operation, AC range reduced to 10 mv, color and mounting varied, etc.
Ranges: AC & DC: .03 — 300 V; Ohms: 10 to 10M.
AC input Z: 1 meg. DC input R: 11 meg.
Freq. Resp.: 20-5,000 cps. **DC zero drift:** .5% max on 1 V & higher ranges; 1% on .03 V range.
Power: 115 V, 400 cps.

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when ordinary instruments are too big or inadequate . . .

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Calif., has been announced by P. R. Mallory & Co., Inc., of Indianapolis, makers of electronic components and metallurgical products.

Milli-Switch will operate under its own name as a subsidiary of P. R. Mallory. Production equipment at the California plant will be moved in the immediate future.

M-H Division Adds Space

ENLARGEMENT of production and engineering facilities of the Heiland Division of Minneapolis-Honeywell Regulator Co., Denver, has been completed. Firm has added 12,000 sq ft to its present plant area—a 25 percent increase—to expand production of its line of oscillographic instruments.

Addition of the new space is the second major physical expansion for the firm within two years. It moved into its new $1-million one-story plant, located on a nine-acre plot in Araphoe County on the outskirts of Denver, in December 1955.

Biggerstaff Joins Calmag

NEW assistant chief engineer and technical assistant to the president of California Magnetic Control Corp., North Hollywood, Calif., is A. J. Biggerstaff. Formerly with Rheem Electronics, he has been assigned to the Calmag Division, which designs and manufactures precision transformers, reactors, magnetic amplifiers and power supplies, and handles special magnetic engineering projects.

NARTB Becomes NAB Again

EFFECTIVE Jan. 1 the National Association of Radio and Television Broadcasters reverts to its former name, the National Association of Broadcasters.

The business association of the

broadcasting industry was organized in 1922 as the NAB. Name lasted until 1951 when it was changed to NARTB, following a merger with Television Broadcasters Association.

Membership of the organization currently is composed of 1,727 radio stations, 319 tv stations, the four national radio networks, and the three national tv networks. Besides there are 117 associate members from allied fields.

New Mexico Firms Merge

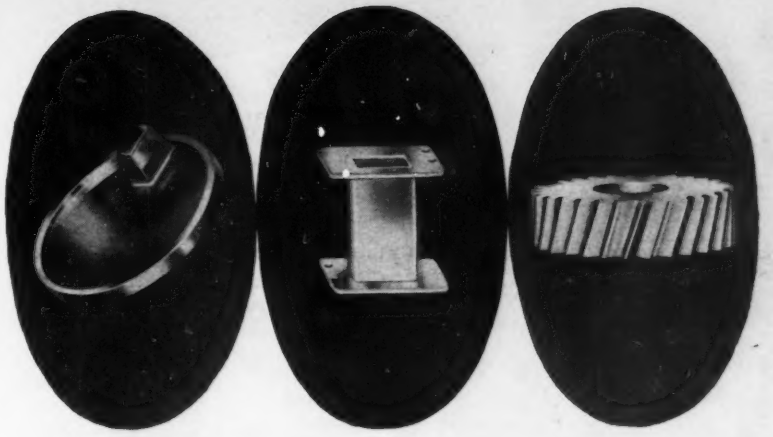
ULTRADYNE, INC., of Albuquerque, N. M., has bought the products and physical assets of Quantum Electronics, Inc., of the same city. This purchase permits the addition of d-c to d-c power supplies, junction transistor analyzers, power transistor analyzers and constant current power supplies to Ultradyne's present line. The firm has specialized in the design, development and manufacture of electromechanical instruments for missiles, aircraft and commercial uses.

Quantum will operate as a division of Ultradyne. To be known as Quantum Electronics, A Division of Ultradyne, Inc., it will be headed by T. E. Lommasson, president and treasurer before the merger. It will continue to specialize in transistor and solid state circuit design.

Cohu Boosts Research

NEWLY announced research division of Cohu Electronics, Inc., will have headquarters in San Diego and laboratories in Van Nuys, Calif., at 14743 Lull St.

The company has brought together a team of scientists headed by Martin L. Klein to do some very specific research and development in the fields of electronic instrumentation and process control. Much of the research will be devoted to bringing the know-how of military, missile and aircraft programs to the industrial production



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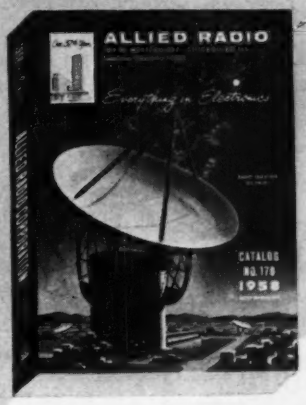

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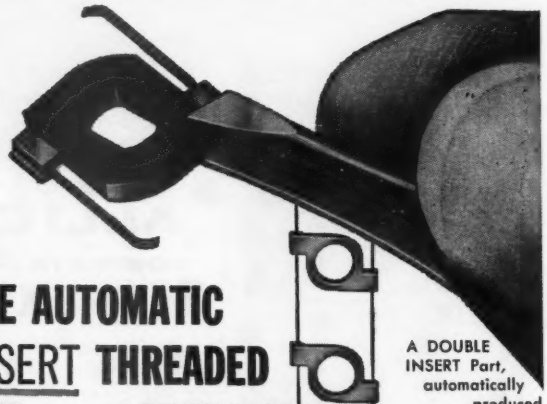

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New instruments to be developed in the research division will complement the present instrument production of the Kin Tel Division of Cohu Electronics in San Diego.

Executive Moves

TECHNICAL products division of Waste King Corp. gets a new chief electronics engineer as **Sam Gilman** moves in from Consolidated Electrodynamics Corp.

Electrical Communications Inc. moves **C. Edward DePuy** in as chief applications engineer.

Alvaro D. Biagi moves into the job of executive engineer for IT&T's Federal Telecommunications Lab.

Jerome E. Vielehr moves from Westinghouse to become sales engineer for Magnetic Inc.'s control division.

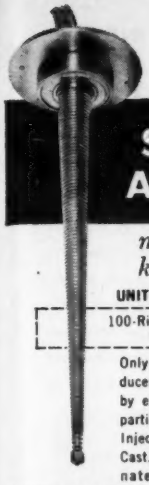
F. O. Robison becomes v-p of Textron's California technical industries division. He also continues as the division's works manager.

Plant Briefs

CONSOLIDATING its operations, **Recony Corp.** moves its administrative offices from New York to Richmond, Va., puts them in the same place as its production plant.

Abilities Inc., a firm employing physically handicapped people in production of electronic gear on subcontract, opens a new plant in Albertson, N. Y.

In Hollister, Calif., **Holex Inc.** opens shop on a 28-acre site to de-



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sign and manufacture packaged explosive power devices and related electronic equipment.

Bell Electronics Co. moves its printed-circuit assembly facilities into new quarters in Valley Forge, Pa.

Neal Feay Co., Santa Barbara, Calif. maker of electronic hardware, plans to build a new 10,000-sq ft plant early this year.

Clifton Precision Products, Clifton Heights, Pa., will build a branch plant in Colorado Springs, Colo., employing 500 people.

New firm in New England: **Hyperion Inc.**, West Newton, Mass.; company will make power supplies and power converters.

News of Reps

RELAY manufacturer, Filtors, Inc., adds to its list of reps **Robert T. Dean.** Located in Ithaca, N. Y., he will cover New York State, excluding Orange, Putnam, Westchester, Rockland and Dutchess Counties, New York City and Long Island.

Sealectro Corp. merchandises its Press-Fit terminals in Canada through Ottawa rep, **M. J. Howard & Co.**

California electronic equipment housing maker, Zero Mfg. Co., appoints **Anderson & Associates** sales reps for Minnesota, Western Wisconsin, North Dakota and South Dakota.

Costello & Co., Los Angeles, get the nod as West Coast rep for the infrared products of Barnes Engineering Co., Stamford, Conn.

Electro-Span sales in Texas, Arkansas and Louisiana, for Pacific Division of Bendix Aviation Corp., are now handled by **William E. Brice Co.**, of Houston, Texas.

New Canadian rep for instruments and components of Control Electronics Co. is Montreal rep firm **Electrodesign.**

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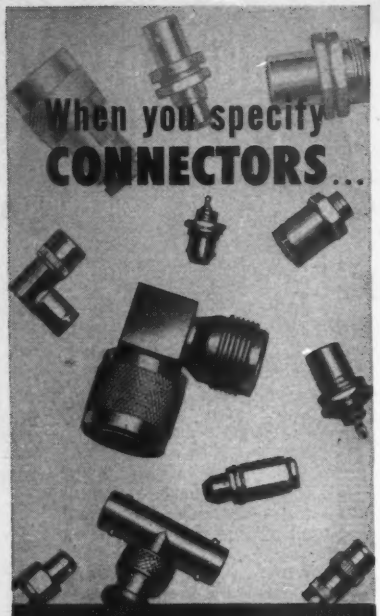

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New Books

Synthesis of Passive Networks

By Ernst A. Guillemin
John Wiley and Sons, New York, 1957, 741 p. $15.00.

During the past decade, the need for a book in the English language, which gives a fairly complete treatment of the realizability and synthesis procedures for passive electric networks, has become quite evident if not acute. In response to this demand, several books are being published in this field all within the current year. This book by Prof. E. A. Guillemin, a well known authority in this field, is a thorough treatment of this subject and represents but one volume of a set of books by the same author which will cover the entire field of network theory.

▶ **Synthesis Procedures**—The book presents both the classical synthesis procedures for driving point and transfer functions and also many results of quite recent origin. In fact, several methods are included which have not had wide publication.

The realizability conditions of driving point and transfer impedances are considered first in the text. Next, the synthesis procedures for driving point impedances involving elements of only two kinds (LC, RL, and RC) are discussed. The treatment continues with a discussion of the properties of two-terminal pair networks and then returns to the problem of synthesizing driving point impedances but, in this case, for general RLC networks. This discussion includes some fairly recent methods, notably Miyata's, for eliminating the ideal transformers which are required in Brune's procedure.

▶ **Transfer Functions** — Professor Guillemin turns his attention next to the methods of realizing transfer functions and here again both classical and some quite recent procedures are presented. The last two chapters deal with the approximation problem, one involving the fre-

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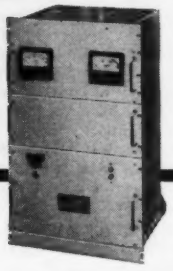

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quency domain and the other dealing with the time domain.

This book fulfills a very definite need at the present time. It is detailed in its treatment and has a clear exposition. One criticism may be made, however. The methods presented emphasize those procedures in whose development Professor Guillemin has been personally involved. However, the coverage is still quite complete and presents much useful information for the network synthesist. — ARMEN H. ZEMANIAN, *Assoc. Prof. of Electrical Engineering, New York University, New York, N. Y.*

Solid State Physical Electronics

BY ALDERT VAN DER ZIEL
Prentice Hall, Englewood Cliffs, N. J., 1957, 593 p, $9.75.

IN presenting a comprehensive introduction to the physics of solid state devices and their application, Mr. van der Ziel has given an excellent text suitable to the student and engineer as a guide to understanding the basic physics that govern the properties of the solid.

"Solid State Physical Electronics" covers the broad field of control and utilization of the electric, magnetic and photic characteristics of solids. The book presents a complete treatment of one of the fastest growing branches of electrical engineering.

▶**Context**—The four major sections of the book, divided into 23 chapters, cover physical principles, electron emission devices, semiconductor devices and dielectric and magnetic devices. The first five introductory chapters present the basic concepts of atomic physics, statistics, the structure of solids and the theory of semiconductors. The author has highlighted here a good portion of the fundamentals of solid state theory.

The following six chapters, devoted to electron emission devices, consider the theory of thermonic emission, practical cathodes, vacuum tube problems, photoemission

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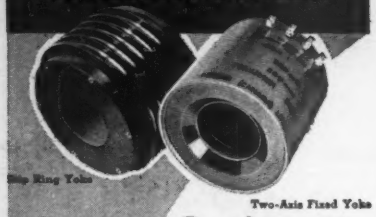

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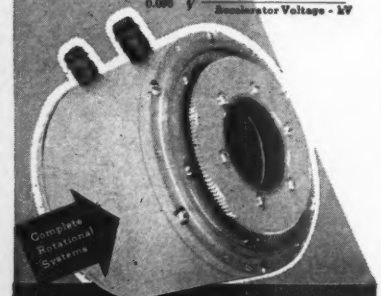

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and secondary emission, as well as device applications.

Semiconductors, the concern of the next eight chapters, review the physics and uses of metal semiconductor contacts, *p-n* junctions, transistors, photosemiconductor, luminescence and light amplification. The last four chapters, dealing with the dielectric and magnetic properties of solids, cover the dielectric, piezoelectric, and ferroelectric devices.

At the end of each chapter are listed additional references, as well as a large number of elementary problems. The problems are well chosen to give the student or beginner a feel for orders of magnitude of devices and characteristics available in the field today.

▶**Background Needed**—The reviewer feels that the text is aimed at the level of the engineering student who has completed his undergraduate physics and mathematics and is ready for introductory solid state physical electronics. In this respect, the book meets the need for an elementary treatment of the basic ideas in solid state physics.

As a text, this book will be useful for courses introducing the subject of solid state devices. Engineers in the field will find "Solid State Physical Electronics" a valuable compilation of the role of solid state in electronics, as well as a reference for the physics involved. —F. BRONSTEIN, *Universal Transistor Products Corp., Westbury, L. I., N. Y.*

Thumbnail Reviews

Handbook of Linear Transducers. Automatic Timing & Controls, Inc., King of Prussia, Pa., 1957, 32 p, $2.00. Theory, characteristics and application of differential transformers for design engineers.

Engineering Properties and Applications of Plastics. By Gilbert F. Kinney, John Wiley & Sons, Inc., New York, 1957, 278 p, $6.75. Background information for utilization or specification on fabricating methods and properties of plastics.

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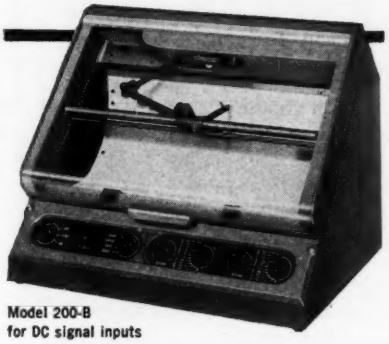

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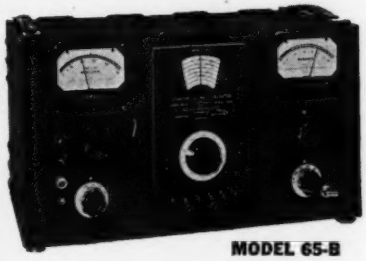

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COMMENT

Miniaturization

Congratulations for the special report ("Miniaturization of Electronic Equipment," Oct. 1, p 177). This is timely and informative.

It is disappointing, however, to find no discussion of costs, aside from the reference in the abstract that "costs generally go up." As a matter of fact, this is an understatement—the costs are sometimes near astronomical!

R. W. Johnson
Interstate Electronics Corp.
Anaheim, Calif.

. . . I just want to call your attention to something that we find fairly annoying. In the report on miniaturization you devote a whole paragraph (p 192) to a description of our M series pulse transformers. However, you refer to us as *Technical* Engineering Co.

T. Kite Sharpless
Technitrol Engineering Co.
Philadelphia, Pa.

. . . The type GM resistor mentioned on pages 190 and 204 was developed and manufactured by the Globar division of the Carborundum Company rather than by Workman Tv Inc.

Joseph S. Demaio
The Carborundum Company
Niagara Falls, N. Y.

Changed Name

We would like to call your attention to page 193 of our October 1 issue, where you have a photo of our unit in a teaspoon. The caption under the photo reads *Autonetics* instead of *Autotronics*.

Fran Haynes
Autotronics Inc.
Florissant, Mo.

For Sale

I would greatly appreciate knowing if anyone would be interested in buying any or all issues of Electronics from 1948 to the present at fifty cents a copy. I do not have storage space for these books and it is necessary that some disposition be made of them.

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